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## Editorial

### Dear authors, reviewers, and readers

It has been a month since I was given the privilege to serve as the Chief Editor of the International Journal for Innovation Education and Research (IJIER). It is a great pleasure for me to shoulder this duty and to welcome you to **THE VOL-9, ISSUE-03 of IJIER** which is scheduled to be published on **1<sup>st</sup> March 2021**.

International Journal for Innovation Education and Research (IJIER) is an open access, peer-reviewed and refereed multidisciplinary journal which is published by the International Educative Research Foundation and Publisher (IERFP). IJIER aims to promote academic interchange and attempts to sustain a closer cooperation among academics, researchers, policy makers and practitioners from a wide range of disciplines, which contribute to state of the art in science, education, and humanities. It provides a forum for the exchange of information in the fields mentioned above by welcoming original research papers, survey papers, and work-in-progress reports on promising developments, case studies, and best practice papers. The journal will continue to publish high-quality papers and will also ensure that the published papers achieve broad international credibility.

The Chief Editor, appointed by the Associate Editors and the Editorial Board, is in charge for every task for publication and other editorial issues related to the Journal. All submitted manuscripts are first screened by the editorial board. Those papers judged by the editors to be of insufficient general interest or otherwise inappropriate are rejected promptly without external review. Those papers that seem most likely to meet our editorial criteria are sent to experts for formal review, typically to one reviewer, but sometimes more if special advice is needed. The chief editor and the editors then make a decision based on the reviewers' advice.

We wish to encourage more contributions from the scientific community to ensure a continued success of the journal. We also welcome comments and suggestions that could improve the quality of the journal.

I would like to express my gratitude to all members of the editorial board for their courageous attempt, to authors and readers who have supported the journal and to those who are going to be with us on our journey to the journal to the higher level.

Thanks,

**Dr Eleni Griva**

Ass. Professor of Applied Linguistics

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# An Analysis of Politeness Strategies and the Maxim Violation in a Movie Script of Enola Holmes

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## Abstract

*The purpose of this research were to find out (1) whether the types of politeness strategies in Enola Holmes movie are in accordance with politeness strategies proposed by Brown and Levinson (1987) or not, (2) what type of politeness strategies most frequently appeared in Enola Holmes movie, (3) which character(s) use politeness strategies most frequently than the others, and (4) what type of violating maxims based on Grice's maxim most frequently appeared in Enola Holmes movie. The design of this research is a descriptive qualitative research. The data of the research were in the form of utterances that contained politeness strategies and cooperation and implicature (Violating of maxim). The result shows that (1) the types of politeness strategies in Enola Holmes movie are in accordance with politeness strategies proposed by Brown and Levinson (1987); (2) Bald on Record is the most frequent politeness strategies appeared in Enola Holmes movie. Bald on Record is mostly used by the characters because there is a power, social status, or close relationship among the characters.; (3) there are three characters who used politeness strategies more frequently, they are Enola Holmes, Sherlock Holmes, and Tewkesbury (4) Violating maxim of relevance is the most frequently appeared in Enola Holmes movie.*

**Keywords:** politeness strategies, cooperation and implicature, violating maxim, Enola Holmes

## 1. Introduction

Language is a system of communication that is used by human to express the idea, information, and feeling. As social beings, people need and involved in daily communication in order to exchange the when they have a conversation. In a conversation, speakers are using statements that reflect a paradigmatic use of language, i.e., making requests, questioning, giving orders, inviting, offering apologies, and so on. Yet, to infer what is said (considering its form and context) is an essential ability for the creation and reception of coherent discourse which would lead to a successful communication. Formulating this knowledge is the essence of what is called the Speech Act Theory. According to Austin (1962), same utterance could at the same time constitute three kinds of acts; they are locutionary, illocutionary, and perlocutionary act. Austin focused on the second of these acts. Illocutionary act is now considered the territory of pragmatics, of meaning in context. Besides, Searle (1979), as an improvement of the classification of the speech acts proposed by Austin, classifies speech acts into five categories, that is, assertive, commissive, directive, declaration, and expressive. Assertive is a statement to describe a state of affairs in the world such as stating, concluding, and describing. Commissive deals with hearers when commit speakers to some future

action such as promising, threatening, and offering. Directive refers to the speakers who attempt to get the addressee to carry out an action such as, requesting, advising, and inviting. Then, declaration is a statement attempt to change the world by representing it as having been changed such as declaring, hiring, and arresting. Expressive, a statement that expresses the sincerity of the speech acts such as greeting, thanking, and apologizing. Therefore, it is beneficial for the speakers and hearers to understand this one basic concept before other concepts in pragmatics.

In addition, a good communication also needs the politeness principle to organize how to communicate and give the information to others. Using politeness can make listeners give a good response to the speaker's question or request. Politeness was showing awareness of another person's face. Monreal (2009:176) defined that face is something that should be recognised and be respected in interaction. Moreover, politeness was related to social distance or closeness (Yule, 2006: 104). Politeness is an important factor in developing effective relationships with people, and any misuse of these strategies can hinder the effective communication, leading to individuals' dissatisfaction and indifference (Pishghadam, 2012). In addition, Karbelani (2013:52) stated that politeness strategies are used to fix some rude utterances, to send speaker meaning, to make utterances acceptable by the hearers. In the design of politeness speech, Brown and Levinson (1987) suggested that some formula that is associated with the concept of politeness. There are bald on record, positive politeness, negative politeness and off record. Using strategies of politeness properly can help us to control ourselves when we communicate with other.

Furthermore, to make an effective communication, conversation must have both the speaker and the hearer who need to cooperate and have contribution that can be understood. The cooperative principle can help people to be cooperative in conversation. According to Grice, the cooperative principle makes your conversational contribution such as is required (cited in Yule, 1996). It means that do not give any information less or more to the listeners. Moreover, Cooperative Principle that has formulated by H. P. Grice can be divided into four maxims, called Gricean Maxims, describing specific rational principles observed by people who obey the cooperative principle; these principles enable effective communication (Renkema 2004: 19). Cooperative principle has four maxims that can help the conversation become more effective. They are maxim of quantity, maxim of quality, maxim of relevance, and maxim of manner. However, people sometimes break the maxims by giving more or less information, being irrelevant, saying something false, and being obscure which called as violating of maxim. The concept and the function of cooperation and implicature are fundamentally linked. This sense of cooperation is simply one in which people having a conversation are not normally assumed to be trying to confuse, trick, or withhold relevant information from each other. Formulating this knowledge provides great opportunity for people in achieving good communication (Yule, 1996).

The concept of speech act, politeness strategies, cooperation and implicature are not only can be seen in real life but also in work like novels, drama or films. Meanwhile, there are a lot of studies shown that watching film or movie is beneficial to improve language competence of English (Kalean, 2013; Ismaili,

2013; Putriani, 2014). Besides, some researchers also have found that films catch the learners' interest and it can positively affect their motivation to learn (Xhemaili, 2013). According to Heider (2006: 1), film is being used to explore the visual and aural possibilities of ethnography, taking us far beyond the traditional printed text. Movie also helps children to expand their experience and heighten their awareness of social and moral dilemma (Downey & A. V. Kelly, 1978:167). In other words, by watching movies, EFL learner requires a consideration of how speakers organize what they want to say in accordance with who they are talking to, where, when, and under what circumstances. In this study, the researcher chooses *Enola Holmes* movie by analyzing the politeness strategies and violating of maxim through the conversation among the characters of the movie. It set out deliberately to inculcate education values into children by the choice of such that movie.

*Enola Holmes* is a 2020 mystery film based on the book series of the same name, written by Edgar Award winner Nancy Springer. The story is about the teenage sister of the already-famous Sherlock Holmes, who goes to London in search of her mother who has disappeared. This story is really appropriated for all aged especially. *Enola* is a fun family movie about an adventurous, smart and confident thing lady. this movie provides amazingly family-friendly, clean, and appropriate movie. It is funny and full of action. Netflix's *Enola Holmes* charmed critics, bringing in a 91 percent rating on *Rotten Tomatoes'* Tomatometer, with over 64 critics weighing in to approve of the newest teen detective. This film is centered on Sherlock Holmes' baby sister, Enola. She is left to fend for herself by her mother, Mrs. Eudoria Holmes, so she learns to be independent as a young woman in the real world. Enola is an amateur young detective, splendid at decoding informative. The film is narrated by the character itself, but the narration makes it look like a YouTube vlog video. This makes it look very realistic. It all teaches tweens and teens, plus their families about expectations of being a woman in the Victorian Era. This movie focuses on the adventure of young lady to find her mother and her identity. This movie shows strong character with a lot of moral value. Based on this different status or power, it is assumed that the characters' ways of politeness strategies used in requesting something to different status are also various depend on to whom they speak.

In accordance to politeness strategies and violating of maxims, there are several previous researches. A study was done by Selfia (2016) who investigated the reason Deddy Corbuzier used politeness strategies in his talk show. The finding showed that by using politeness strategy, the host wants to show his interest, sympathy and friendliness. The host also wants to show his closeness to the guest stars through this strategy. In addition, Supriyanta (2017) found that positive politeness strategy is used to do something, satisfy someone else, or minimize the FTAs that may threaten the hearers' faces. While, with regard to violating maxims, there are also several researchers who interested to study this topic. Alfina (2016) found that the motivation behind the speakers violating the maxim is mostly because they want to show politeness and keep other's self-esteem. Sari, Nuraini, and Muthalib (2019) found that maxim violation holds an important role in maintaining the effectiveness of communication.

Viewed from previous studies, most researchers analysed the concepts of politeness strategy and violating of maxims separately. Yet, the current researcher investigates both of those pragmatics concepts in a study

to make the concepts become more meaningful. A better communication can be achieved when people understand the politeness strategies and its relation to cooperative principle and implicature at the same time. Since this study concerns to the politeness strategies and cooperation and implicature used by the characters, thus this research will use Brown and Levinson in Yule (1996) classification of politeness and cooperation and implicature by Grice (1975). The objectives of conducting this present study are to find out:

- (1) whether the types of politeness strategies in Enola Holmes are in accordance with politeness strategies proposed by Brown and Levinson (1987) or not,
- (2) what type of politeness strategies most frequently used by the characters in Enola Holmes movie,
- (3) which character(s) use politeness strategies more frequently than the others, and
- (4) what type of violating maxims based on Grice's maxim most frequently appeared in Enola Holmes movie.

## **2. Theoretical Background**

This section presents theories that will be used to analyze the results of the literature review.

### **1.1. Politeness Strategies**

In the field of politeness, Brown and Levinson's work (1987) is the best known and the most researched. In their work they attempt to relate the following aspects: face, facework and acts that threaten face, sociological variables influencing face threat, and five general ways (or 'superstrategies') of counterbalancing face threat with (at least some) specific linguistic strategies. What is face? Notions such as reputation, prestige, and self-esteem, all involve an element of face. The term is perhaps most commonly used in English in the idiom "losing face", meaning that one's public image suffers some damage, often resulting in humiliation or embarrassment. Such reactions are suggestive of the emotional investment in face. In this study the researcher uses the theory of politeness strategies proposed by Brown and Levinson (1987). There are four types of politeness strategies proposed by Brown and Levinson. There are bald on record, positive politeness, negative politeness and off record. Further, direct statements that are always associated with imperative forms and get the listener directly know what speaker means or what the speaker want the listener do is characterized as bald on record. This strategy is usually employed in some occasion, such as in emergency situation, unequal power relationship, and task oriented activities. In everyday interaction such bald on record statements would potentially represent a threat to the other's face and would generally be avoided. Avoiding a face threatening act is accomplished by face saving acts which use positive or negative politeness strategies. A positive politeness strategy leads the requester to appeal to a common goal, and even friendship. This strategy can be seen as a solidarity strategy. While, negative politeness shows awareness of other's need for independence. It is typically expressed via questions, even questions that seem to ask for permission to ask a question. This strategy also uses modal in its form. In politeness strategies, if speakers do not have to ask for anything, even they decide to say something, it is called by off record. This strategy may or may not be succeed, but if it is does it will be because more has been communicated than was said.



### 1.2. Politeness as Intentionality

Intentionality is used in the social sciences today with two interrelated meanings: In one sense, it relates to purposiveness, involving means-ends reasoning in planning a desired outcome as in “She missed the target intentionally” (Bratman 1999). In the second sense, which incorporates the first, intentionality is a feature of the mind such that it is capable of being directed at, being about, and representing thoughts, beliefs, desires, emotions and intentions (in the sense of “to intend to”) and capable of attributing such mental states to others (Searle 1983). According to the cognitive intentionalist stance toward human communication, this representational capacity accounts for the emergence of meaning as propositions explicitly stated or inferred, propositional attitudes (e.g., disbelief) and expressive (i.e. non-propositional) impressions (e.g., impressions of disrespect, intimacy, etc.) that hearers develop based on verbal and non-verbal cues in interaction and their understanding of speaker intentions (Gibbs 1999; Sperber & Wilson 1995[1986]). For example, the addressee of the utterance “It’s gonna rain” may represent this representation of the world as “She has said that it will rain” or attribute a belief to the speaker in the form of “She believes that it will rain.” This would be a metarepresentation of a thought of the speaker (cf. Wilson 2000: 414). The utterance may also be represented as “She intends me to believe that she believes that it will rain” or “She intends me to believe that it will rain.”

### 1.3. Cooperative Principles

The concept of being an expected amount of information provided in conversation is just one aspect of more general idea that people involved in a conversation will cooperate with each other. The assumption of cooperation is so pervasive that it can be stated as a cooperative principle. Cooperative principle is to make sure your conversational contribution such as required, at that stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged. There are four types of maxims; maxim of quantity, maxim of quality, maxim of relevance, and maxim of manner (Grice in Yule, 1996). In maxim of quantity, the speakers must make their contribution as informative as required and they are not allowed to make the contribution more informative than is required which means that the speakers also neither give too much nor too little information (Grice in Yule, 1996). Then, when the speakers give the information that it is true, it means they follow the criteria of maxim quality (Grundy, 2000). While, in the maxim of relevance, the speakers are required to be relevant in saying something. To fulfil this maxim, the speakers are expected to say something relevant to what is said before. Last, in maxim relevance, Grice asserted that the speaker tends to be perspicuous, be brief, and be orderly, to avoid ambiguity and obscurity of expression (Grice in Yule, 1996). It means that the speaker must say something clear and should not be vague in a conversation.

### 1.4. The Violating of Maxim

Violating towards maxims can mislead a hearer. Grice states (as cited in Peter and Morgan, 1975) “people may quietly and unostentatiously violate a maxim, if so, in some cases he will be liable to mislead” (p.49). Violating can also happen in four sub principles of maxim. The maxim violation according to Thomas (1995) differs from flouting. In maxim violation, someone does not realize that he/she has been deceived, whereas flouting of maxims are meant to be noticed. On the other hand, breaking a maxim happens when

a speaker with no intention of generating an implicature fails to observe a maxim. The reason for this is imperfect linguistic performance which can be due to, for example: an imperfect command of the language, or because the speaker's performance of the language is somehow impaired, or because of some cognitive impairment or because the speaker is incapable of speaking clearly, and so on (Thomas, 1995). There are violating towards maxim of quantity, quality, relation, and manner. According to Cutting (2002), violating towards maxim of quantity happens when a speaker does not give enough information to a hearer about the whole picture or the topic being discussed. Then, violating towards maxim of quality is a situation where a speaker is not sincere and gives wrong information to a hearer, which can be said as lie. Cutting (2002) says "speaker can violate the maxim of quality by not being sincere and tend to give wrong information to a hearer" (p.40). Furthermore, violating towards maxim of relation happens when a speaker change the topic to avoid the answer or topic that brought by other interlocutors in conversation. Cutting (2002) defines that violating in maxim of relation happens when speakers try to distract and change the topic to another one. The last is violating towards maxim of manner. Cutting (2002) defines that violating towards maxim of manner happens when someone gives obscure reference, and vague reference, in order to avoid a brief and orderly answer in a conversation.

### **3. Method**

This research used descriptive qualitative design. The source of this research was the movie and the script of Enola Holmes by Edgar Award. The data of this research was the utterances of the whole characters and the context of the data was also the utterances that contained politeness strategies, cooperation, and violating maxims in Enola Holmes movie. The research instrument was the researcher herself. In this case, the researcher planned the research, collected the data, analyzed the data and gave a conclusion of the research since the data used qualitative research. Moreover, there are several steps in collecting the data. First, the researcher watches and replays the film entitled Enola Holmes several times in order to understand the whole of the story. Second, the researcher looked at the script as well and compared it to the movie in order to be sure towards the data obtained. Third, the researcher determines the parts of the dialogues that contain the certain forms of positive politeness strategies and implicature. Fourth, the researcher identifies and classifies the data by giving code on each data based on the theories of positive politeness strategies and theories of cooperation and implicature. The data were coded by number and classified based on five strategies of politeness theory proposed by Brown and Levinson (1987) and theory by Grice (1975). To make the datum coding clearer, the researcher gives an example as presented below.

#### **6/EH/PS/PP/VM**

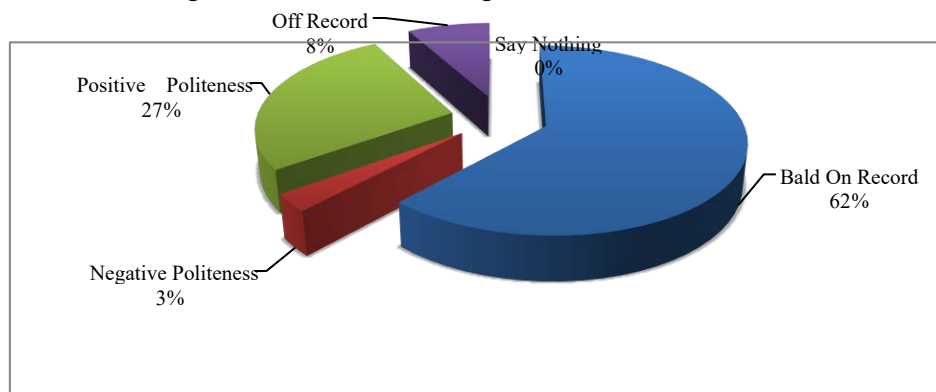
The coding above means that the datum is number six (6). EH means Enola Holmes. PS is politeness strategies and PP is one of politeness strategies applied in that datum that is Positive Politeness. Meanwhile, VM means Violates Maxim of Manner.

### **4. Result and Discussion**

#### **4.1. Dealing with the first and second research questions**

Having analyzed the politeness strategies used from the utterances in Enola Holmes movie, the researcher found out the result to answer the research questions. It was presented as in the following chart

Chart 1. The Percentage of Politeness Strategies Used In Enola Holmes.



There are 88 utterances which belongs to the classification of politeness strategies proposed by Brown and Levinson. From those requests, there are 3 data belongs to Negative Politeness strategy (3%), 24 data belongs to Positive Politeness strategy (27%), 54 data of Bald on Record strategy (62%), 7 data of Off Record strategy (8%), and 0 data from Say Nothing strategy. This result indicates that the type of politeness strategies exist in Enola Holmes movie are in accordance with the classification of politeness strategies proposed by Brown and Levinson. Moreover, Bald on Record strategy has the highest proportion among others (62%). Further, close relationship and social status affect the way of characters utter the utterance. Since this movie tells the relationship between siblings, friends, and many characters that have higher social status or close relationship tend to use direct and imperative sentence to control others' behaviour. Thus, the characters in Enola Holmes movie more frequently use bald on record strategy than the others. This strategy was used more frequently by Enola when she was in dangerous situation and requested something to her brothers in order to control their behaviour. Her close relationship to brothers and her social status as the sister of Sherlock and Mycroft affects her utterances in requesting and asking something. This following part showed the analysis for each politeness strategies used by the characters in Enola Holmes movie.

#### a. Positive Politeness

*Extract 1* represents conversation between Enola and her new friend Tewksbury. He run away from his parents and the news has spread all over the city. Enola met him to tell the news

Datum Number: 5/EH/PS/PP

**Tewksbury:** And why have you done so? You're here for the money. They've offered a reward.

**Enola Holmes:** Have they? I didn't know. Well, I must tie you up and claim it!

[she grabs him and laughs]

Intention: She intends to express her happiness by meeting him

Enola and Tewkesbury have pretty close relationship since they are in the journey to go to London together. They face many challenges and decide to separate their way in London. Enola know the killer will follow him. She worries and tries to save him. She is looking for him. The dialogue contains positive politeness especially in a joke.

*Extract 2* represents conversation between Sherlock and Mycroft as Enola's brothers. Sherlock see her sister skill as detective and he asks Mycroft to be her guardian instead of him.

Datum Number: 10/EH/PS/PP

**Sherlock Holmes:** Nevertheless, if we do find her again, I'd like her to be my ward. I'll take care of her.

**Mycroft Holmes:** Well, on your head be it. I washed my hands of her.

**Sherlock Holmes:** Very well. All the better.

Intention: He intends him to ask the permission of their sister

Mycroft wants to bring her sister back to the boarding school so she will have best education. Sherlock know, it is not what she wants. Enola wants to be free. Sherlock employs an offer and a promise to take care of her sister.

#### b. Negative Politeness

*Extract 2* is taking between Eudoria and Enola. Eudoria leave Enola without any clue. They meet again in small house secretly.

Datum Number: 25/EH/PS/NP

**Eudoria Holmes:** I'm sorry. I'm sorry. I wanted to tell you where I was going, but it wasn't safe.

**Enola Holmes:** Are you safe now?

**Eudoria Holmes:** I didn't leave you because I didn't love you. I left for you, because I couldn't bear to have this world be your future. So I had to fight

Intention: She intends her to forgive and believe about the reason

From this conversation, we can see Eudoria feel sorry. This dialogue employs negative politeness, apologizing, the speaker can indicate her reluctance to impinge on hearer negative face

*Extract 2* shows mother and daughter conversation. It shows how the miss each other. Enola tries her best to find her mother

Datum Number: 26/EH/PS/NP

**Eudoria Holmes:** Oh, it's funny. I thought I was the one that was going to change the world. The reform bill, is it true what you did?

**Enola Holmes:** Yes Mother [Enola laughs as she cries]

**Eudoria Holmes:** What a woman you've become.

[Enola embraces her]

Intention: she intends to express her happiness and sadness by looking her grown up daughter

From this conversation, both Enola and Eudoria communicate cooperatively. Eudoria give appreciation to the hearer Enola by giving a compliment. It also preserves the negative face of the addressee.

c. Bald On Record

*Extract 1* shows Enola's brother reaction about his little sister that have not met for so long in the station.

Datum Number: 40/EH/PS/BOR

**Sherlock Holmes:** Enola.

**Mycroft Holmes:** My God. Look at you! You're in such a mess. Where's your hat and your gloves?

Intention: He intends her to believe that she looks so terrible and different

Enola and her brothers have not met for 10 years. Mycroft thought Enola has become elegant woman.

Enola is in hurry so she fall on the ground and her clothes is covered with mud. This conversation using strategy that embarrass the addressee. "Look at you" means he is surprised by the appearance of his dirty sister.

*Extract 2* shows that Enola forces Tewkesbury to jump from the train in order to save their life.

Datum Number: 46/EH/PS/BOR

**Enola Holmes:** Listen, Tewkesbury. We have two choices.

**Tewksbury:** And which one involves me not dying?

**Enola Holmes:** This one!

[she takes his hand jumps off the train before Linthorn captures them]

Intention: She intends to force him to follow her direction

In this conversation, Enola saves Tewkesbury and decides to jump off the train together. Besides, he uses bald on record strategy to control Tewkesbury's behaviour. As the result, Tewkesbury follows Enola's command. Bald on record is applied because they are in urgent situation.

d. Off Record

*Extract 1* happens when Enola on the way to save Tewkesbury.

Datum Number: 81/EH/PS/OR

[as Enola has a flashback memory of her mother]

**Eudoria Holmes:** Paint your own picture, Enola. Don't be thrown off course by other people. Especially men!

Intention: She intends to express her thought toward the world and individuality

A glimpse of her mother's memory suddenly come up when she tries to save her friends. She is confused whether to find the clue of her mom or save her friends. In the middle of her way, she chooses her friend by forgetting her mom's message "paint your own picture" which means that Enola should think and prioritize herself first. Therefore, it is specified as off record utterance.

*Extract 2*, the conversation is between Enola and Tewkesbury who run from the boarding school to reveal the killer.

Datum Number: 83/DPS/PS/OR

**Enola Holmes:** Sometimes, Lord Tewkesbury, you have to dangle your legs in the water to attract the bloody sharks!

**Tewksbury:** Why would we want to attract the bloody sharks?!

**Enola Holmes:** Good point.

Intention: She intends him to believe that she has a great idea to save both of them

Enola remembers her brother messages and tries to explain it to Tewkesbury. She does not have to ask anything, so she uses Idiom as the hint to do later. Then, it seems that Tewkesbury get the point of Enola's utterance. It is an idiom about to sacrifice yourself first little bit and catch the killer.

#### 4.2. Dealing with the third research question

This present study also shows that each character in the movie used different politeness strategy to different people he or she spoke to request something. There are twelve characters in Enola Holmes movie. Some characters used all the types of politeness strategies, some just use one or two types. The following table is the frequency of each character to use politeness strategies in the movie.

Table 1. The Politeness Strategies Used by Each Character in Enola Holmes Movie.

Characters	Positive Politeness	Negative Politeness	Bald On Record	Off Record	TOTAL
Enola Holmes	11	-	15	2	28
Sherlock Holmes	1	-	11	-	12
Mycroft Holmes	2	1	4	-	7
Ms. Lane	-	-	5	-	5
Inspector Lestrade	-	-	1	1	2
Linthorn	-	-	-	1	1
Edith	1	-	-	-	1
The Dowager	1	-	3	-	4
Lady Tewkesbury	-	-	2	-	2
Tewskbury	5	-	10	1	16
Miss Gregory	-	-	2	-	2
Eudoria Holmes	3	2	-	2	7
TOTAL	24	3	54	7	88



Based on the table above, there are two characters who used politeness strategies more frequently in requesting something, they are Enola Holmes and Tewkesbury who used some types politeness strategies. Enola Holmes and Tewkesbury who used Positive Politeness, Bald on strategies, and Off Record and Sherlock who only used Bald On Record Strategy and Positive Politeness.

#### 4.3. Dealing with the fourth research question

This study also investigates the violating maxims that exist in 88 utterances. They are maxim of quantity, maxim of quality, maxim of relevance and maxim of manner. The following table is the frequency of implicature (violating maxims) that exist in the movie.

Table 2. The Violation of Maxim in Politeness Strategies Used In Enola Holmes Movie

	Violating of Maxims				Cooperation	TOTAL
	Quality	Quantity	Relevance	Manner		
Positive Politeness	1	1	3	1	18	24
Negative Politeness	1	-	-	-	2	3
Bald On Record	5	1	11	-	37	54
Off Record	1	-	-	-	6	7
TOTAL	8	2	14	1	63	88

Based on the table above, some utterances violate some maxims. Violating maxim of relevance has the highest proportion among the others. It means, both speaker and hearer ought to make a relatable contribution about something being discussed. If they discuss something that unmatched with the topic, it means they violate the maxim of relation. Here, the data were given with detail explanation.

##### a. The Violation of Maxim of Quantity

In the following conversation, Enola picks up her brothers in the station. They are angry after knowing that her sister looks very dirty and uneducated.

Datum Number: 62/EH/PS/PP/VQN

<b>Mycroft Holmes</b>	:	My God. Look at you. You're in such a mess. <b>Where's your hat and your gloves?</b>
<b>Enola Holmes</b>	:	<b>Well, I have a hat. It just makes my head itch. And I have no gloves.</b>

The weather is so cold and all the women should wear hat and gloves to show their social identity. Enola comes from high profile family, her first brother is really concern with these stuff. Mycroft notices of

aspect of Enola condition and asks her. She gives too much information about the reason which are not suitable with Mycroft's question.

#### b. The Violation of Maxim of Quality

This following conversation shows that Enola is caught by the killer (Lingthorn). He tries to choke because Enola knows his secret.

Datum Number: 79/EH/PS/OR/VQL

<b>Linthorn</b>	:	That's a shame. <b>Well, you've seen my face..</b>
<b>Enola Holmes</b>	:	<b>No, your face is totally unmemorable!</b> (close the door and ignore the order)

Linthorn statement is incomplete by leaving an FTA half undone. He leave the implicature hanging in the air just as with rhetorical question. He tries to threaten Enola and Enola tell a lie to save herself. She knows and remembers linthorn's face that is why she tries to get away from him

#### c. The Violation of Maxim of Relevance

In this following conversation, Sherlock tries to find the clue about his mother in her bedroom and asks Enola some questions about her education.

Datum Number: 22/DPS/PS/PP/VR

<b>Sherlock Holmes:</b>	:	<b>Enola, you at least had a governess? (Check mother's room)</b>
<b>Enola Holmes</b>	:	<b>She wouldn't like you in here. This is her private space.</b>

In the dialogue above, Sherlock worries about her sister condition. He tries to search the clue and asks the condition of her sister because he knows exactly his mother. Instead of replying Sherlock question directly. She tries to keep her mother's stuff save. Therefore, she violates maxim of relevance since his answer is not relevant. Sherlock uses a straightforward strategy with positive politeness. This strategy is directly addressed to the positive face of the speech partner, so that the partner feels comfortable.

#### d. The Violation of Maxim of Manner

In this following conversation, Enola shares the idea to catch the killer. He is confused with the ideas.

Datum Number: 55/EH/PS/OR/VM

<b>Enola Holmes</b>	:	Sometimes, Lord Tewkesbury,
<b>Tewksbury</b>	:	you have to dangle your legs in the water to attract the bloody sharks!
<b>Enola Holmes</b>	:	<b>Why would we want to attract the bloody sharks?!</b>
		<b>Good point.</b>

Purposeful ambiguity may be achieved through metaphors, since it is not always clear exactly which of the connotation of metaphors are intended. Enola's response violated the maxim of manner for being not straight to the point. It happens since she does not want to tell the exact reason to the Tewkesbury.

## 5. Conclusion

Based on the findings, the researcher concludes that in Enola Holmes movie, the characters use all type of politeness strategies, cooperation and implicature. There are four politeness strategies found in Enola Holmes movie clip which are suitable with the application of Brown and Levinson's theory of politeness. Further, Bald on Record strategy is more frequently occur in this movie. In this movie, this strategy is commonly used in expressing the urgent situation and conveying the sympathetic advice or warnings. Many speakers realize the advantage of employing a bald on record strategy, especially for those who have social status. Bald on Record is beneficial for the speakers to express clarity and directness in speaking. Moreover, Enola Holmes uses politeness strategies most frequently than the others. Bald on Record is frequently used than the other politeness strategies; it is because the close relationship among the characters. Followed by positive politeness, it occurred to minimize the distance between character by expressing friendliness and solid interest. It can be seen when Enola explored the city and met new people.

In addition, the characters in this movie violates all the types of maxim and maxim of relevance is the most violated. The characters changed topic all of sudden to avoid the questions that causing the violation of maxim relation. This action caused the interlocutors to be confused. The violation of maxim relevance placed first because the message that speaker delivered or tried to convey sometimes not in line with the message that the hearer received. Then, the interlocutor did not give the proper answer and instead gave the unmatched response. As the result, the feedback became unsuitable and much different from the expectation. By employing certain ways, the character violated the maxims in order to save face, hide the truth, please the hearer, build someone's believe, avoid punishment, avoid discussion, and express feeling. Thus, the communication considered fully ineffective.

In short, Enola Holmes is appropriate to be watched by EFL students since it gives many moral values and also provides great understanding about politeness strategy, cooperation and implicature.

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# Inoculation with plant growth-promoting bacteria and reduction of nitrogen fertilizer in herbage accumulation and nutritional value of Mavuno grass

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## Abstract

*Strategies that improve the use of nitrogen (N), by tropical forage grasses, can bring environmental and social gains. Thus, this study aimed to evaluate the forage productivity and the nutritional value (NV) of the hybrid Urochloa spp. cv. 'Mavuno', under inoculation with plant growth-promoting bacteria (PGPB) and doses of N. The experiment was carried out in the field, for a period of 14 months, in a randomized block design, with nine treatments and four replications in plots of 9 m<sup>2</sup>. Seed inoculations were tested with: Azospirillum brasilense Ab-V5 and Ab-V6 strains; Pseudomonas fluorescens CCTB 03 and co-inoculation with Rhizobium tropici CIAT 899 and A. brasilense Ab-V6, combined with 50 and 100 kg ha<sup>-1</sup> of added mineral N; fertilization with N-mineral with these doses, without inoculation and the control treatment, without N and without inoculation. The bacteria were inoculated to the grass seeds. The forage was evaluated by determining the shoot dry weight yield (SDWY) and the levels of crude protein (CP), neutral detergent insoluble fiber (NDF), acid detergent insoluble fiber (ADF) and in vitro dry matter digestibility (IVDMD). The results were subjected to analysis of variance by the F test ( $p \leq 0.05$ ) and compared to each other by the Scott-Knott test at 5% probability. Inoculation with PGPB resulted in greater SDWY when associated with a dose of 50 kg ha<sup>-1</sup> of N. In plants inoculated with A. brasilense Ab-V5 + Ab-V6 and P. fluorescens CCTB 03, associated with a dose of 50 kg ha<sup>-1</sup> of N-mineral, SDWY was similar to that obtained with double the dose of N in the absence of inoculation. The inoculation with PGPB resulted in an increase in the NV of Mavuno grass, with emphasis on A. brasilense Ab-V5 + Ab-V6 and P. fluorescens CCTB 03, associated with the dose of 100 kg ha<sup>-1</sup> of N-mineral that improved the nutritional value in all evaluated items. The inoculation with A. brasilense Ab-V5 + Ab-V6 was the most promising, followed by P. fluorescens CCTB 03, mainly in association with 50 kg ha<sup>-1</sup> of N.*

**Keywords:** crude protein, tropical forage grass, diazotrophic bacteria, Urochloa spp.



## 1. Introduction

At the end of 2019, Brazil was home to 213.7 million cattle and 1.4 million buffalo [1] raised, in large part, on the 180.3 million hectares of pastures [2]. Part of this area has some degree of degradation. Nitrogen fertilization in pastures is little used, although several studies show its effectiveness [3]; [4]; [5]. Nitrogen (N) is a high-cost input in pasture production. The discovery and use of rational technologies are essential, since the increase in meat and milk production is achieved with the use of large quantities of mineral fertilizers.

The inoculation of forage grass seeds with plant growth-promoting bacteria (PGPB) has shown positive results in recent studies [6]; [7]; [8], this technique could reduce nitrogen fertilization costs in tropical pastures [9]; [10].

The industrial synthesis of ammonia, through the traditional Haber-Bosch process, is currently responsible for 1.2% of anthropogenic CO<sub>2</sub> emissions [11], therefore, using microorganisms that make biological nitrogen fixation (BNF) and promote plant growth by other mechanisms is a sustainable alternative [12] for the nutrition of forage plants.

Inoculation with PGPB has been studied in maize (*Zea mays*) [13]; [14], sorghum (*Sorghum vulgare*) [15], wheat (*Triticum aestivum*) [16], sugar cane (*Saccharum officinarum*) [17], soy (*Glycine max*) [18], beans (*Phaseolus vulgaris*) [19] and recently in forage plants [20]; [21], this technique can be used as a strategy to increase plant productivity [22]. The partial replacement of nitrogen fertilizers by inoculants containing *Azospirillum* can reduce CO<sub>2</sub> emissions [23].

Mavuno grass is a hybrid, resulting from the cross between (*Urochloa ruzizienses* x *U. brizantha*) x *U. brizantha* [7], launched in Brazil in 2013, has been used for pasture production in tropical regions [24], however, little is known about the response of this cultivar to inoculation with PGPB.

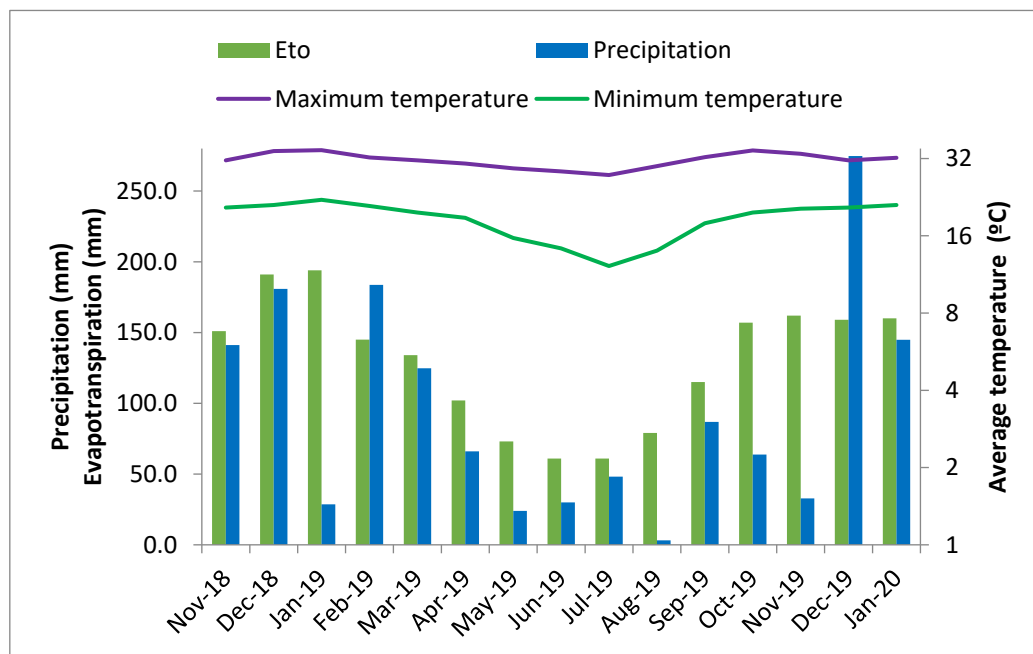
The hypothesis of this work is that the inoculation in the seeds of Mavuno grass with PGPB associated with N fertilization doses, allows to reduce the amount of N and obtain high productivity of forage dry mass with high nutritional value.

The aim of this study was to evaluate the effect of N doses and seed inoculation with *Azospirillum brasilense* Ab-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* CIAT 899 + Ab-V6 on productivity and the NV of Mavuno grass, grown in a dystrophic Red Yellow Argisol.

## 2. Material and methods

### *Site and experiment description*

The experiment was carried out in the field, from November 2018 to January 2020, at the Animal Science Experimental area of the Faculty of Veterinary Medicine, São Paulo State University – UNESP, Araçatuba Campus, located in the northwest region of the State of São Paulo, Brazil, at 390 meters above sea level, latitude 21° 11 '12"S and longitude 50° 26' 20"W, the climate is Aw, according to the Köppen classification [25]. The data of monthly accumulated precipitation and average maximum and minimum temperature are shown in Figure 1.



**Figure 1.** Monthly averages of air temperatures, maximum and minimum (°C), accumulated precipitation and reference evapotranspiration (mm) during the experimental period. (2018/2020). Source: [26].

Before sowing, soil was collected for chemical analysis, evaluating the need for liming and fertilization with potassium and phosphorus. The sampled soil was classified as dystrophic Red Yellow Argisol, according to the Brazilian Soil Classification System [27].

Sampling was carried out at a depth of 0 to 0.20 m. Chemical determinations were made according to the methodology of [28]: for P, K, Ca and Mg using the ion exchange resin method; pH in  $\text{CaCl}_2$ ; organic matter by colorimetry; H + Al with SMP buffer solution; Al in KCl. The results were: organic matter =  $24 \text{ g dm}^{-3}$ ; pH = 4.9; P, S, B, Cu, Fe, Mn and Zn of 9; 1; 0.19; 1; 80; 9.8 and  $1.2 \text{ mg dm}^{-3}$ , respectively; K, Ca, Mg, H + Al, Al, SB and CEC of 1.9; 13; 11; 30; 1; 25.9; and  $55.9 \text{ mmolc dm}^{-3}$ , and base saturation (V) = 46.3%, respectively.

The population of diazotrophic microorganisms in the soil was estimated using the most probable number (MPN) technique in the N-Free NFBsemi-solid culture medium, according to [29] and [30], obtaining the value of  $9.5 \times 10^4$  bacteria  $\text{g}^{-1}$  of soil.

In order to increase the base saturation to 70%, the soil was corrected with the application of  $1.3 \text{ t ha}^{-1}$  of dolomitic limestone with 90% PRNT [31]. The application of the limestone was carried out 30 days before sowing, by haul, followed by incorporation with a plow of discs at a depth of 20 cm.

Before sowing,  $60 \text{ kg ha}^{-1}$  of  $\text{K}_2\text{O}$  were applied in the form of potassium chloride and  $100 \text{ kg ha}^{-1}$  of  $\text{P}_2\text{O}_5$  in the form of simple superphosphate. Sowing was done manually, in blocks divided into plots of  $3.0 \text{ m} \times 3.0 \text{ m}$  ( $9 \text{ m}^2$ ).

### Statistical design and treatments

The bacteria used were supplied by Embrapa Soybean Soil Biotechnology laboratory, the inoculants were prepared in culture media suitable for each microorganism, in the final concentration of  $2 \times 10^8$  cells

ml<sup>-1</sup>. For each kilogram of seed, 15 ml of inoculum were mixed and allowed to dry in the shade for 30 minutes before sowing, in soil prepared for seeding. The cultural value of the seed was 76% and the sowing rate was equivalent to 9 kg ha<sup>-1</sup> of pure viable seeds.

Sowing was carried out on November 13, 2018, in a randomized block design with nine treatments and four replications, totaling 36 experimental units. The treatments are described below: (1) without N and without inoculation, (2) 50 kg ha<sup>-1</sup> of N without inoculation, (3) 100 kg ha<sup>-1</sup> of N and without inoculation, (4) 50 kg ha<sup>-1</sup> of N and inoculation with *Azospirillum brasilense* strains Ab-V5 (CNPSO 2083) and Ab-V6 (CNPSO 2084), (5) 100 kg ha<sup>-1</sup> of N and inoculation with *A. brasilense* strains Ab-V5 and Ab-V6, (6) 50 kg ha<sup>-1</sup> of N and inoculation with *Pseudomonas fluorescens* CCTB 03 (CNPSO 2719), (7) 100 kg ha<sup>-1</sup> of N and inoculation with *P. fluorescens* CCTB 03, (8) 50 kg ha<sup>-1</sup> of N and co-inoculation with *Rhizobium tropici* CIAT 899 (CNPSO 103, SEMIA 4077) and *A. brasilense* Ab-V6 and (9) 100 kg ha<sup>-1</sup> of N and co inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6.

### **Evaluation of productivity and nutritional value of Mavuno grass**

During the experimental period, six cuts were made (01/17/2019; 03/06/2019; 04/12/2019; 05/31/2019; 12/06/2019 and 01/24/2020) to evaluate the Mavuno grass. The cuts were made when the average height of the plants reached 0.50 m, through sampling. A metallic square with an area of 1.0 m<sup>2</sup> was used, leaving a residue of 0.15 m high above the ground [24], with the use of cleavers. The squares were positioned at representative points of each plot, and through the forage contained inside it was possible to determine the weight of the green mass of forage.

The samples were dried in a forced ventilation oven at 65 ° C for 72 hours, according to [32] and the forage mass values were converted to kg of dry mass per hectare.

After the drying period, the samples were ground in a Willey knife mill with a 1 mm sieve and subjected to chemical analysis.

The levels of neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined by the method of [33] adapted for a Tecnal TE-149 fiber determiner. After determining the NDF, the residual fiber was incubated to determine the ADF.

The *in vitro* dry matter digestibility (IVDMD) was determined using the technique described by [34], modified by [35] with an ANKOM adaptation [36], in an ANKOM daisy<sup>II</sup> incubator and a Tecnal TE-149 fiber analyzer. In summary, the samples were incubated for 48 hours in the ANKOM Daisy<sup>II</sup> incubator, using ruminal fluid from cattle fed with tropical grasses. After incubation, the samples were subjected to the NDF analysis described above and the digestion residues were determined and used to calculate digestibility.

The determination of the N-total content occurred by sulfuric digestion followed by distillation by the micro-Kjeldahl method following the description of AOAC [37]. The crude protein content of the plant was calculated by multiplying the total N-content by 6.25 [32].

The data were tested for the normality of errors and homogeneity of variances. The results were subjected to analysis of variance by the F test ( $p \leq 0.05$ ) and compared to each other by the Scott-Knott test at 5% probability, with the SISVAR statistical analysis program [38].

### 3. Results and discussion

#### *Shoot dry mass yield (SDMY)*

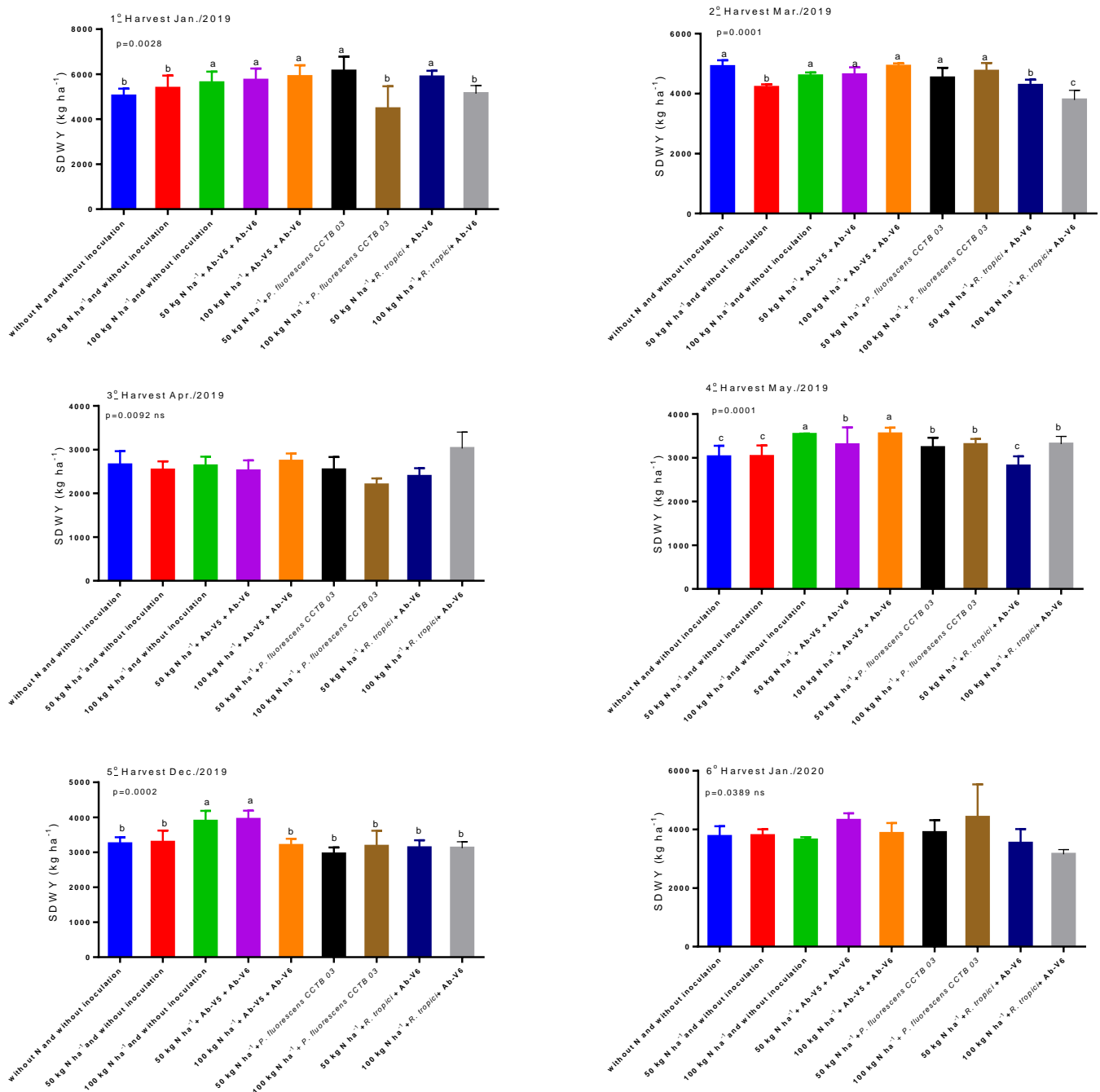
The SDMY values differed statistically from each other ( $p \leq 0.05$ ) in the first, second, fourth and fifth assessment cuts (Figure 2).

The inoculation with *A. brasilense* Ab-V5 + Ab-6 in association with the dose of 50 kg ha<sup>-1</sup> of N, increased SDMY in the first, second, fourth and fifth evaluation cuts by 6.6%, 9.9%, 8.7% and 13.7%, respectively, compared to treatment with the same dose of mineral N and without inoculation. The results agree with [8], who observed in *U. brizantha* cv. Marandu, under inoculation with *A. brasilense* Ab-V5 + Ab-6, an increase of 13% in SDMY in the first year of evaluation, in relation to the control treatment, when compared to those obtained in this experiment that presented, in the average of the evaluations, an increase of 9.7%.

The inoculation with *P. fluorescens* CCTB 03, in association with a dose of 50 kg ha<sup>-1</sup> of N, resulted in an increase in SDMY in the first, second and fourth evaluation cuts by 14.2%, 7.5% and 6.6 %, respectively, when compared to treatment with the same dose of mineral N and without inoculation. A similar effect was observed by [20], in *U. ruziziensis*, with increased biomass productivity in response to a dose of 50 kg ha<sup>-1</sup> of mineral N in association with inoculation with *P. fluorescens* CCTB 03 and also with *P. fluorescens* ET76.

In the first evaluation cut, co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6 associated with a dose of 50 kg ha<sup>-1</sup> of N, showed SDMY 9.3% more than that observed in the treatment with the same dose of N in the absence of inoculation. At a dose of 50 kg ha<sup>-1</sup>, inoculations resulted in statistically similar SDMY.

No inoculation with PGPB associated with a dose of 100 kg ha<sup>-1</sup> of N promoted an increase in productivity when compared to the same dose of N without inoculation, with a negative effect of inoculation on SDMY, as reported by [20], in *U. ruzizienseis*, under inoculation of *A. brasilense* Ab-V5, *A. brasilense* Ab-V6, *P. fluorescens* CCTB 03, *P. fluorescens* ET76 and *Pantoea ananatis* AMG 521.



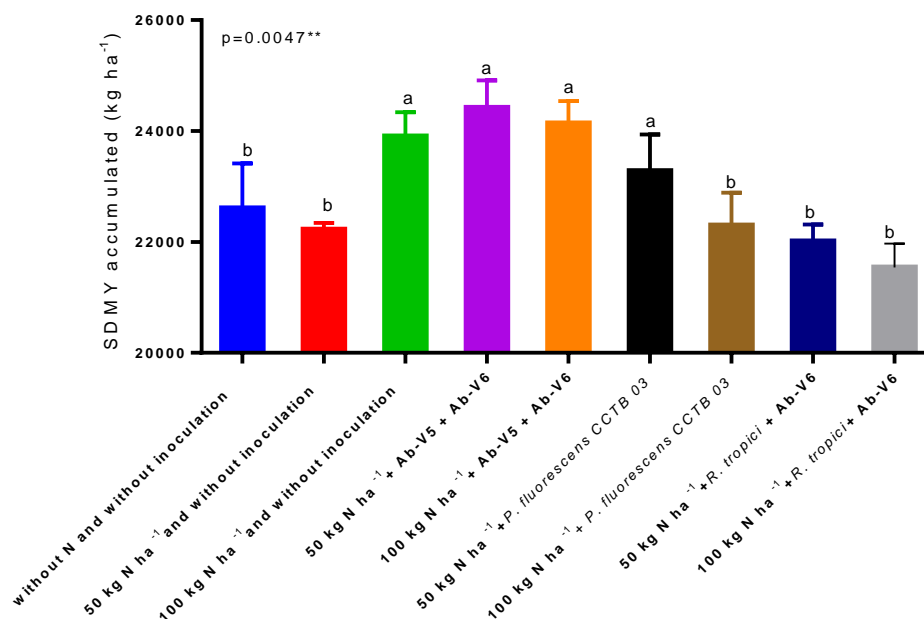
**Figure 2** – Shoot dry mass yield (SDMY) (kg ha<sup>-1</sup>) of Mavuno grass under inoculation with *A. brasilense* AB-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* + *A. brasilense* Ab-V6, in association with nitrogen fertilization at 50 and 100 kg ha<sup>-1</sup> N doses and the control without N and without inoculation. The error bars represent the standard deviation. The averages followed by lowercase letters differ for treatments using the Scott-Knott test ( $p \leq 0.05$ ). ns = not significant.

The inoculation with *A. brasilense* Ab-V5 + Ab-V6 associated with a dose of 50 kg ha<sup>-1</sup> of N resulted in SDMY similar ( $p \leq 0.05$ ) to that obtained with the dose of 100 kg ha<sup>-1</sup> of N and without inoculation in the first, second and fifth evaluation cuts, the same occurred with inoculation with *P. fluorescens* CCTB 03 in the first and second evaluations. This result was also obtained with the co-inoculation with *R. tropici*

CIAT 899 and *A. brasilense* Ab-V6 in the first cut, showing an increase in the efficiency of nitrogen fertilization when the inoculation with PGPB is associated with smaller doses of mineral N.

Adding the SDMY of the six cuts, the accumulated productivity of the shoots was obtained. The inoculation with *A. brasilense* Ab-V5 + Ab-V6 and *P. fluorescens* CCTB 03, in association with the dose of 50 kg ha<sup>-1</sup> of mineral N, did not differ and were higher in 9.9% and 4, 7%, respectively, when compared to the same dose of mineral N without inoculation (Figure 3).

In the absence of inoculation, fertilization with 50 kg ha<sup>-1</sup> of N did not result in SDMP greater than that obtained with treatment without inoculation and without nitrogen fertilization. It is likely that in treatments with inoculation, greater root growth occurred, consequently, greater absorption of N in periods of water deficiency.



**Figure 3** - Shoot accumulated dry mass yield (kg ha<sup>-1</sup>) in Mavuno grass under inoculation with *A. brasilense* Ab-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* + *A. brasilense* Ab-V6, in association with nitrogen fertilization at doses 50 and 100 kg ha<sup>-1</sup> of N and the control without N and without inoculation. The error bars represent the standard deviation. The averages followed by lowercase letters differ for treatments using the Scott-Knott test ( $p \leq 0.05$ ). \*\* = Significant ( $p \leq 0.01$ ).

Similar results were reported by [39], working with *U. brizantha* cv. Paiaguás under inoculation with *A. brasilense* Ab-V5 + Ab-V6, both in the absence and in association with fertilization with mineral N.

Similar results have been reported by [23], in *Urochloa brizantha* and *U. ruzizienses*, with the inoculation of the bacteria *A. brasilense* Ab-V5 + Ab-V6 in association with fertilization with 40 kg ha<sup>-1</sup> of N, observed an average increase of 22.1% in productivity of forage in relation to treatment without inoculation and without N, while fertilization with N without inoculation increased the accumulation of forage by only 5.4%.

Co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6, associated with a dose of 50 kg

ha<sup>-1</sup> of N, did not increase forage accumulation, being 11% lower than that obtained with *A. brasilense* Ab-V5 + Ab-V6 and 5.8% lower than that provided by inoculation with *P. fluorescens* CCTB 03. Under this co-inoculation, the accumulation of forage did not differ from that achieved by fertilization with 50 kg ha<sup>-1</sup> of N and no inoculation.

With the application of 100 kg ha<sup>-1</sup> of N, the inoculation of seeds with PGPB did not increase the accumulated SDMY, as observed by [9] in *Megathyrus maximus* cv. BRS Zuri.

### **Nutritional value of Mavuno grass**

#### **Crude protein (CP) in the shoot**

Inoculation with PGPB increased the CP content of the biomass in the second, third, fourth and fifth evaluation cuts (Figure 4).

In association with the 50 kg ha<sup>-1</sup> dose of N, inoculation with *A. brasilense* Ab-V5 and Ab-V6 increased the CP content by 11.9% and 17.8% in the fourth and fifth cuts, respectively, compared to the same fertilization in the absence of inoculation. A similar effect was reported by [20], in *U. ruziziensis* under inoculation of the two strains separately and doses of N.

Co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6 associated with a dose of 50 kg ha<sup>-1</sup> of N promoted an increase of 12.7% in the CP content, in the third cut, in comparison with the same dose of N and in the absence of inoculation.

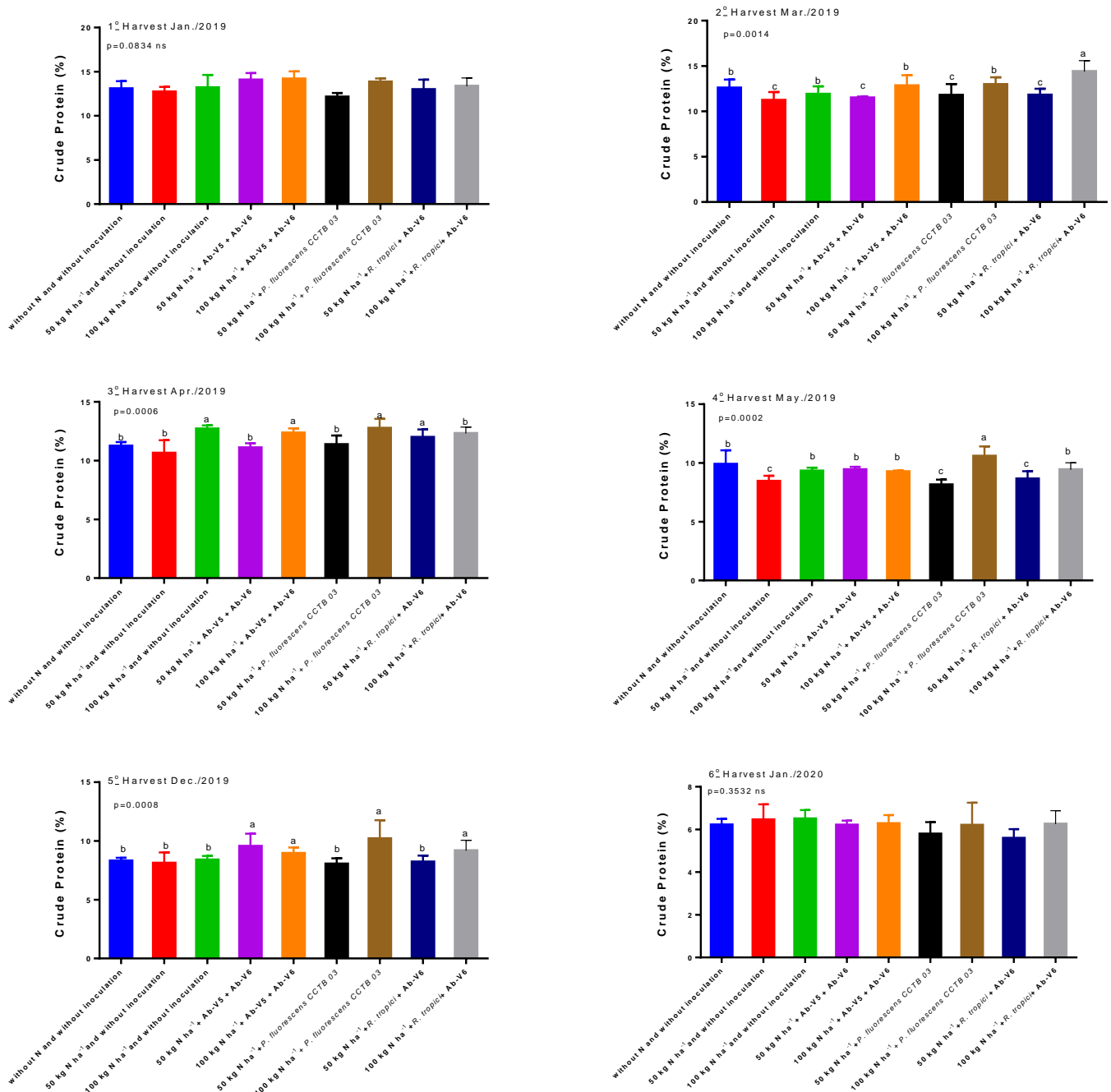
The inoculation with *P. fluorescens* CCTB 03 associated with a dose of 50 kg ha<sup>-1</sup> of N did not promote an increase in the CP content of the shoot, when compared to the same fertilization with N and absence of inoculation. Similar results were found by [7] in Mavuno grass, also by [6] and by [40] in *M. maximus* cv. BRS Zuri.

In association with a dose of 100 kg ha<sup>-1</sup> of N, inoculation with *P. fluorescens* CCTB 03 promoted an increase of 13.4% and 21.7% in the CP content in the fourth and fifth cuts, respectively, compared to the same fertilization without inoculation.

In the second and fifth evaluation cut, co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6, combined with 100 kg ha<sup>-1</sup> of N, increased the CP content by 21% and 9.4%, respectively.

With fertilization of 100 kg ha<sup>-1</sup> of N, inoculation with *A. brasilense* Ab-V5 and Ab-V6 increased the CP content by 6.7% in the fifth cut, but did not differ statistically from the other inoculations. Similar results were reported by [9] in *M. maximus* cv. BRS Zuri, in this same dose of N, and by [41], in *M. maximus* cv. Mombasa, with *A. brasilense* Ab-V5 + Ab-V6, regardless of the associated N dose.

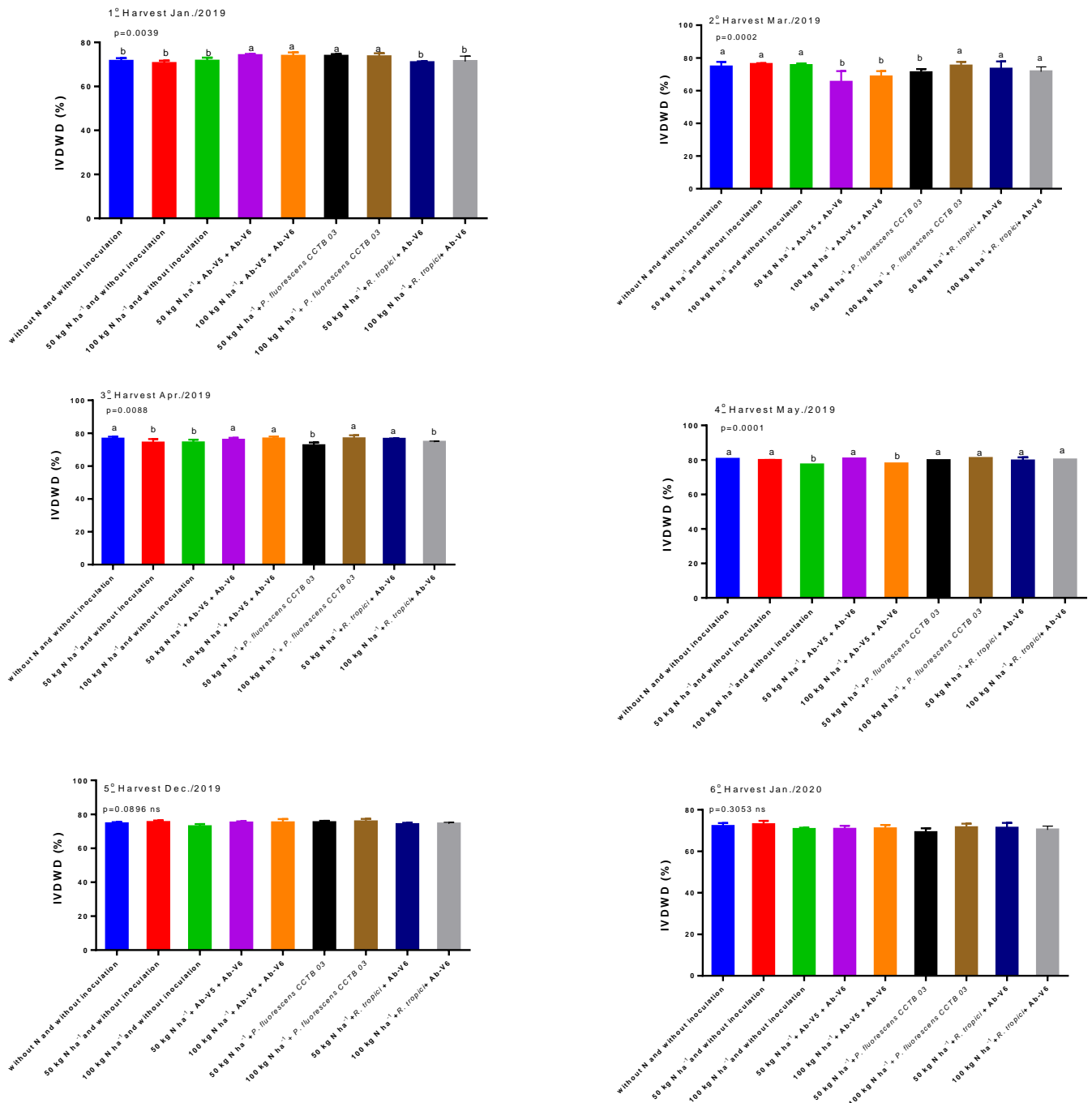




**Figure 4** – Crude protein content (% CP) of the shoot in 'Mavuno' grass under inoculation with *A. brasilense* Ab-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* + *A. brasilense* Ab-V6, in association with nitrogen fertilization at doses 50 and 100 kg ha<sup>-1</sup> of N and control, without N and without inoculation. The error bars represent the standard deviation. The averages followed by lowercase letters differ for treatments using the Scott-Knott test (p ≤ 0.05). ns = not significant.

### *In vitro* dry weight digestibility (IVDWD)

There was a significant difference between the means of IVDWD in the first four assessment cuts (Figure 5).



**Figure 5 - In vitro dry weight digestibility (% IVDWD) of the shoot of Mavuno grass, under inoculation with *A. brasilense* Ab-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* CIAT 899 + *A. brasilense* Ab-V6, in association with nitrogen fertilization at doses 50 and 100 kg ha<sup>-1</sup> of N and the control, without N and without inoculation. The error bars represent the standard deviation. The averages followed by lowercase letters differ for treatments using the Scott-Knott test ( $p \leq 0.05$ ). <sup>ns</sup> = not significant.**

The increase in IVDWD is due to the increase in the nitrogen fraction, with consequent proportional reduction of the cell wall [42]. This is a desirable characteristic in forage plants intended for feeding ruminants for better nutrition.

Studies showing the effect of PGPB inoculation on IVDWD in tropical forages are rare [9] and [42].

The inoculation with *A. brasilense* Ab-V5 + Ab-V6, in association with a dose of 50 kg ha<sup>-1</sup> of mineral N, increased the IVDWD by 5.1% and 2.4% in the first and third cuts, respectively.

For the dose of 100 kg ha<sup>-1</sup> of N, inoculation with *A. brasilense* Ab-V5 + Ab-V6, provided an increase in IVDWD of 3.0% and 3.3% in the first and third cuts, respectively, while in the second cut, there was a 10.1% reduction in IVDWD (Figure 5). The observed increments agree with those obtained by [42], with *U. ruziziensis*, under inoculation with *A. brasilense* Ab-V5 and Ab-V6 separately, the authors reported an increase in IVDWD in three cuts of *U. ruziziensis* and a reduction in one cut.

The inoculation with *P. fluorescens* CCTB 03 associated with a dose of 50 kg ha<sup>-1</sup> of N promoted a 4.7% increase in IVDWD in the first cut, not differing from inoculation with *A. brasilense* Ab-V5 and Ab-V6. For the dose of 100 kg ha<sup>-1</sup> of N, such inoculation increased the IVDWD by 2.7%, 3.4% and 4.8% in the first, third and fourth cuts, respectively. In the first and third cuts, at the highest dose, there was no statistical difference between inoculation with *A. brasilense* Ab-V5 + Ab-V6 and *P. fluorescens* CCTB 03.

Similar results were obtained by [42], who observed in *U. brizantha* cv. Paiguás, under inoculation with PGPB and N fertilization, in seven evaluations performed, the bacterium *P. fluorescens* CCTB 03 promoted an increase in IVDWD in three cuts.

Co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6, in association with doses of 50 kg ha<sup>-1</sup> of N, promoted an increase of 3.1% in the third cut, a result statistically similar to that obtained with *A. brasilense* Ab-V5 and Ab-V6. While at the dose of 100 kg ha<sup>-1</sup> of N, co-inoculation increased IVDWD by 3.8%, not differing from inoculation with *P. fluorescens* CCTB 03.

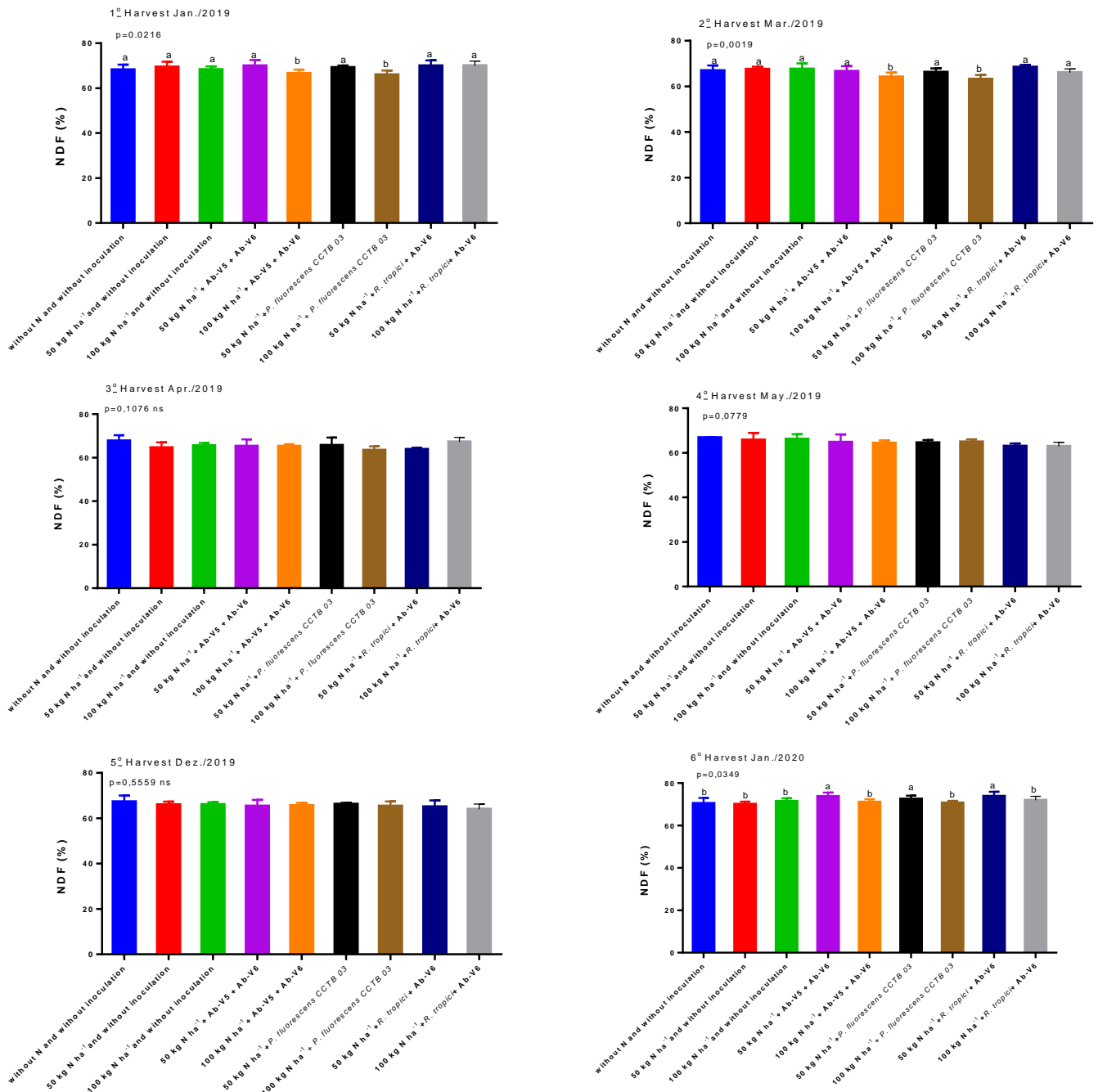
Increased IVDWD was also observed by [9], in a study with *M. maximus* cv. BRS Zuri under inoculation with the same bacteria studied here, associated with a dose of 100 kg ha<sup>-1</sup> of N.

### Neutral detergent fiber (NDF)

The lower the NDF content, the better the quality of the forage, that is, the greater the cellular content in relation to the cell wall. NDF consists of cellulose, fiber-bound N, hemicellulose and lignin [43]. There was a statistical difference in NDF levels in the first, second and sixth assessment cuts (Figure 6).

In association with a dose of 50 kg ha<sup>-1</sup> of N, inoculation with PGPB did not reduce the levels of NDF, in the sixth cut, caused an increase in the levels of NDF, causing a reduction in NV. [7] did not observe a reduction of the NDF contents in Mavuno grass and in *M. maximus* cv. BRS Zuri [40] under inoculation with these same PGPB.

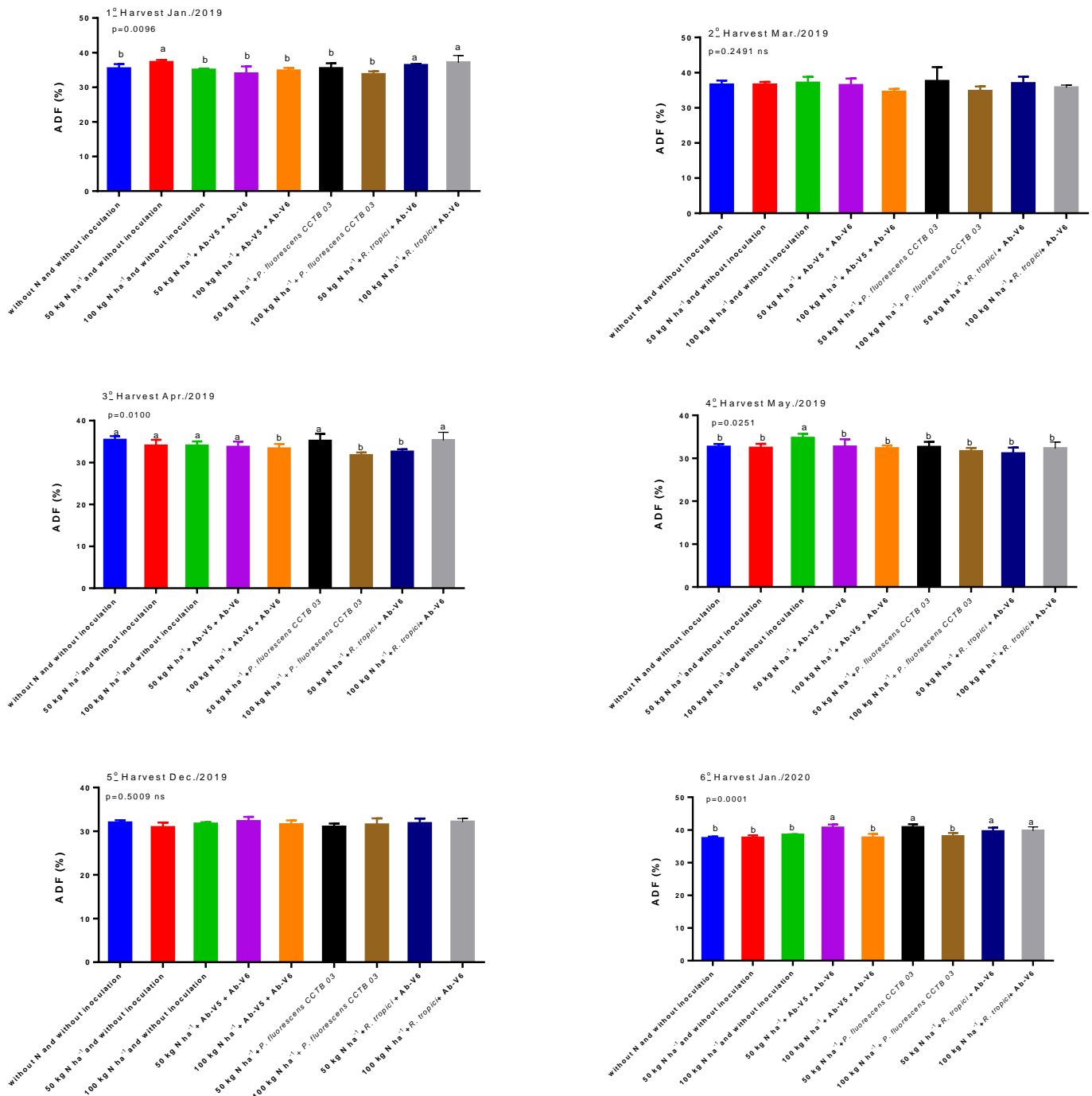
At the dose of 100 kg ha<sup>-1</sup> of N, inoculation with *A. brasilense* Ab-V5 + Ab-V6 resulted in a reduction of the NDF content by 2.6% in the first cut and 5.3% in the second cut, while inoculation with *P. fluorescens* CCTB 03 resulted in a reduction of 3.5% and 7% in the NDF content in the first and second cuts, respectively. There was no statistical difference between the two inoculations above, while co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6 did not affect the NDF content.



**Figure 6** - Neutral detergent fiber (NDF) content of the shoot of Mavuno grass under inoculation with *A. brasilense* Ab-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* + *A. brasilense* Ab-V6, in association with nitrogen fertilization at doses 50 and 100 kg ha<sup>-1</sup> of N and control, without N and without inoculation. The error bars represent the standard deviation. The averages followed by lowercase letters differ for treatments using the Scott-Knott test ( $p \leq 0.05$ ). ns = not significant.

### Acid detergent fiber (ADF)

The ADF is the fraction of the forage that is least digestible for ruminants. It is composed almost entirely of lignocellulose [43]. The ADF contents of the forage differed in the first, third, fourth and sixth cuts (Figure 7). Smaller values indicate a higher forage NV.



**Figure 7** - Content of acid detergent fiber (ADF) in the shoot of Mavuno grass under inoculation with *A. brasilense* Ab-V5 + Ab-V6, *P. fluorescens* CCTB 03 and co-inoculation with *R. tropici* + *A. brasilense* Ab-V6, in association with nitrogen fertilization at doses 50 and 100 kg ha<sup>-1</sup> of N and control, without N and without inoculation. The error bars represent the standard deviation. The averages followed by lowercase letters differ for treatments using the Scott-Knott test (p ≤ 0.05). <sup>ns</sup> = not significant.

In association with the dose of 50 kg ha<sup>-1</sup> of mineral N, in the first cut, inoculations with *A. brasilense* Ab-V5 + Ab-V6 and with *P. fluorescens* CCTB 03 reduced the levels of ADF by 9.7% and 5, 0%, respectively, but without statistical difference between them. In this same dose of N, co-inoculation with

*R. tropici* CIAT 899 and *A. brasilense* Ab-V6 reduced the ADF content by 4.5% in the third cut, improving the nutritional value of the forage, in agreement with [40], who observed similar results in Mavuno grass, under nitrogen fertilization and inoculation with the same PGPB studied here.

In the sixth cut, for the dose of 50 kg ha<sup>-1</sup> of mineral N, inoculation with PGPB resulted in higher levels of ADF, consequently reducing the NV of the forage.

In the fertilization with 100 kg ha<sup>-1</sup> of N, inoculation with *A. brasilense* Ab-V5 + Ab-V6 reduced the ADF content by 2.0% and 7.3% in the third and fourth cuts, respectively, and the inoculation with *P. fluorescens* CCTB 03 reduced ADF content by 7.3% and 9.9% in the third and fourth cuts, respectively, but without statistical difference between the two inoculations.

In combination with 100 kg ha<sup>-1</sup> of N, co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6 resulted in a 7.5% lower ADF content in the fourth cut, in agreement with [9], who observed a reduction in ADF levels in *M. maximus* cv. BRS Zuri, under inoculation with the same PGPB tested here.

#### 4. Conclusions

In association with a dose of 50 kg ha<sup>-1</sup> of N, inoculation with *A. brasilense* Ab-V5 + Ab-V6 increased the forage yield in 4 cuts, *P. fluorescens* CCTB 03 increased in 3 cuts and the co-inoculation with *A. brasilense* Ab-V6 + *R. tropici* CIAT 899 increased in one cut, such benefit of PGPB was not observed in the dose of 100 kg ha<sup>-1</sup> of N.

Mavuno grass inoculated with *A. brasilense* Ab-V5 + Ab-V6 and *P. fluorescens* CCTB 03, fertilized with 50 kg ha<sup>-1</sup> of N, accumulated dry forage mass similar to the application of 100 kg ha<sup>-1</sup> of N in the absence of inoculation.

Inoculation with PGPB, at a dose of 50 kg ha<sup>-1</sup> of N, improved the NV in the IVDDM and ADF items, but did not influence the NDF content. The bacteria, except *P. fluorescens* CCTB 03, also increased the CP content.

At a dose of 100 kg ha<sup>-1</sup> of N, PGPB increased NV in a more pronounced way, in all variables analyzed, except NDF that was not affected by co-inoculation with *R. tropici* CIAT 899 and *A. brasilense* Ab-V6.

#### 5. Acknowledgement

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# **Overview on the Production and Commercialization of “Barreado” in Paraná Coast, Brazil: Implications and Potentialities**

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## **Abstract**

*Barreado is a typical dish from Paraná, made with beef and some specific spices and cooked for a long time in a clay pot sealed by a mixture of ashes similar to the clay, being this dish produced with greater relevance in the coastal region of the state, where there is the largest productive arrangement of this dish in Brazil and where has a strong gastronomic touristic appeal. Despite the historical, cultural and economic relevance of gastronomic tourism in Paraná, few and sparse studies use the issue, thus, this study aimed to elaborate and show an overview of the current scenario of production and trade of the dish, highlighting the implications and potential of Barreado in Paraná Coast. The survey methodology was based on quantitative and qualitative descriptive exploratory research, the data collection was accomplished between May and June 2020, with 151 consumers. The study revealed that among Barreado consumers there was a predominance of women (n=61.5%). The average age was 40.9 years old, and the majority of*

*the respondents (46.4%) preferred to consume Barreado when it is done by the traditional way of cooking, in a clay pot and on a wood stove for 24 hours. The greatest potential described was the fact that the Barreado is a typical and original product of Paraná and has great acceptance in gastronomic tourism, which reveals its capacity to be a source that drives regional development, however the price considered high and the distribution network in the retail market was classified as deficient, they were identified as limiting factors to the development of the Barreado production and commercialization. In this context, still on the issue of price and its relationship with the consumption, given that it was one of the main factors identified as limiting and the lack of studies on the subject, for further studies on the cost and quality relationship should be considered by researchers in new future studies.*

**Keywords:** Gastronomic Tourism; Cultural Appreciation; Morretes; Typical Dishes; Regional Cuisine.

## 1. Introduction

Brazilian gastronomy is diverse, especially due to the use of regional ingredients that allows a high mixture of flavors, which is still influenced by the regional culture. Culture and customs rooted in a people can hardly be separated from the cuisine, especially when it is taken into account those that are restricted to a specific geographic region (GANDARA; GIMENES, 2009). The symbolic gastronomy of a region can commonly be considered as crucial for the tourism development, because in addition to the food, they involve rites, traditions, values, cultural and symbolic practices of the communities where several types of typical dishes are practiced (GIMENES, 2011).

The offer of typical regional dishes according to Barroco and Barroco (2008), are always associated with tourism, because this offer goes beyond eating, it has a meaning for local society and culture and it becomes an object of curiosity for visitors, being precisely for this cultural contrast that awakens the desire for consumption, which in addition to the monetary value itself it brings traditions, operating memories, imaginations and unique meanings of the people who are linked to it. Gimenes (2011) corroborates the previous statements and points out that the gastronomy, besides being crucial for the tourism development, also raises the esteem of the people who are involved in this process.

Brazilian tourism occurs on a large scale in the coastal regions, where in addition to the charms of the natural beauty, according to Azevedo and Neto (2010), the cuisine is also a relevant factor in attracting tourists in Brazil. Specially in relation to the Paraná Coast, according to Anacleto et al. (2020) it has a strong influence of seasonal tourism, especially during the summer time, when it receives thousands of tourists from various Brazilian regions, and for this reason, over time, the population started producing and marketing a wide variety of typical products in order to offer to tourists.

According to Gimenes (2011), among the regional gastronomy products that had great acceptance, the typical dish called Barreado stands out, which is made with beef, some specific spices and cooked for a long time in a clay pot, being classified as typical food and produced only in Paraná, being the coastal region the largest producer, and where the delicacy has a strong tourist appeal.

The tourism in Paraná Coast, according to Anacleto et al. (2020) has an increasing importance for the regional economy, being among the main income-generating activities and opportunities for the coastal

municipalities, especially in the summer time, when a weekly and rotating number of people, greater than five times the regional population moves to the region, and a significant part of these tourists according to Hoffmann (2010) travel to the Northern portion of the Coast, especially to Morretes and Antonina, cities that have the greatest offer of the dish.

Barreado has significant relevance in this region, especially in Morretes its main tax collection sources is related to the tourism, with Barreado being considered the main attraction of gastronomic tourism. In this context, Anacleto et al. (2020) highlight that the strengthening of tourism can be understood as one of the alternatives of regional development, capable of bringing ways of increasing the families' income. Therefore, gastronomic tourism should be considered more comprehensively by the government as an alternative for social transformation, and this issue is most evident Paraná Coast.

Despite the historical, cultural and economic relevance of gastronomic tourism in Paraná, few and sparse studies use this issue, thus, this study aimed to elaborate an overview on the current scenario of the Barreado production and commercialization, highlighting the implications and potential of the dish in the coastal region of the State.

## **2. Literature review**

The news of the discovery of gold in Paranaguá, in the 16th century, according to Gortz and Siqueira (2013) attracted a greater number of Portuguese colonists to the region, among them those from the Azores, who landed in Antonina in 1720, when they discovered a type of delicacy made by the natives, they appreciated the dish, and over time they made changes in the preparation of the dish, using clay pots and mixtures of ash with water to cover it and thus prevent the entry of sand in the cooking. Because of this new way of elaborating the dish, the "Moqueado" (slowly cooked) as it was called by the natives, was renamed as Barreado, due to the mixture of ash and water that served to seal the the clay pot and prevent it from the entry of sand (GORTZ; SIQUEIRA, 2013).

The way of preparing Barreado according to Gimenes, (2011) has undergone new changes over the following decades, however the historical aspects of its origin have always been maintained, as well as the character of regional identification.

Mascarenhas and Ramos (2008) reported that over time goes by Barreado has strengthened like a meat stew made on the plateau and brought by the drovers (tropeiros) on the way between Curitiba and Morretes, especially during the yerba mate (erva mate) cycle. The meat used was not tender meat an aspect linked to the limitations of the caboclos (mixed of Brazilian Indigenous and European) from the Paraná Coast, and also because it is a meat resistant to the prolonged cooking, and Barreado was considered a nutritious dish, due to its energy value and practicality of its preparation, with few accompaniments, and it kept the flavor preserved, even when reheated (GIMENES, 2011).

Barreado then, since the drovers period, became one of the main delicacies associated with the Paraná Coast and with the development of the tourism it started to be offered and accepted by tourists. The Northern of the coast, which includes Antonina, Paranaguá, Guaraqueçaba and especially Morretes according to Anacleto et al. (2020) constitutes an important LPA - Local Productive Arrangement, this LPA



is based in the production and trade of Barreado, being estimated that 94% of all the production of the state occurs in these cities.

The gastronomy according to Gimenes (2011) is decisive for the tourist development, through a series of activities that can allow the visitor to know other cultures, to experience other rites and traditions. The culinary expression represents a historical cultural heritage, of different groups of society, and this reproduction in the consumption of regional food awakens in tourists the desire of knowing more deeply other cultures and their symbolic values.

The symbolic value in the case of gastronomic tourism, occurs through the affective judgment of a person, and with the direct influence created with the human values, by the decision at the moment of choices through the evaluation of the value and analysis of its characteristics with tangible and intangibles attributes of a product or service (ALLEN, 2001), however it is worth mentioning that there are other aspects in the development of a visitor's decision in the case of tourism, arising from the scenario analysis based in the available alternatives. Such multiple alternatives are closely related to psychological methods, particularities of conceptions, practices and formation of precepts that are intermediated by cognitive responses from personal experiences and desires.

In this context, valuing tradition can generate positive impacts on the local economy, since the incentive to the culture would allow return through the generation of jobs and income to the local community, significantly increasing the opening of new businesses and as consequence the development of the region. Local development is understood as a process that mobilizes people and institutions in order to transform the economy and the local society, creating opportunities for work and income, overcoming difficulties to favor the improvement of the local population living conditions.

Rocha et al. (2019) describe that it is essential that local and regional development is guided by diagnostic studies that present the current scenario in which the productive system is found and the conditions that can generate implications or potentialize the development of this productive arrangement. Still according to the authors, the overview obtained based on the testimonies of people who use products or services, are able to generate solid bases to guide actions to induce development

### **3. Methodology**

The survey methodology was based on quantitative and qualitative descriptive exploratory research (GIL, 2008), the data collection was accomplished based on the self-perception of the consumers without worrying about the use of statistical techniques.

The study according to Fontelles et al. (2006) aimed to organize a diagnosis of the current situation of consumers' perception about the production and trade of the delicacy from Paraná Coast, and the interviews were conducted between May and June 2020, with 151 consumers.

According to what was proposed by Vergara (2015), data collection was accomplished with a semi-structured interview with a pre-prepared question script. The interview in question was conducted using digital media after previous contact by e-mail.

Initially, the interviewees answered questions about their socioeconomic profile, and later, they answered questions about production and commercialization of Barreado and in the last stage of the interview they answered questions regarding the implications and potential of the dish in the region.

The importance level of the delicacy was assessed using the summation scale or Likert scale with an assessment of the degree attributed by the interviewees who promoted a hierarchical categorization ranging from none to high importance.

As implicações econômicas foram aferidas com o uso de respostas similares e percentuais e também com a organização de uma matriz de impacto cruzado. A matriz de impacto cruzado foi realizada similarmente ao proposto por Anacleto e Prazeres (2020), os autores descrevem a matriz como sendo o cruzamento das implicações entre si mediante o relato da autopercepção dos entrevistados. A matriz emprega valores percentuais de 0 a 100 a cada opinião exposta pelos entrevistados em relação as demais opiniões expressadas, comparando cada item analisado na relação de influência exercida e a influência sofrida nas práticas cotidianas na gestão das pousadas, assim quanto maior o índice, maior a relevância e a atenção a ser dada a situação problemas vivenciados pelos gestores.

The economic implications were assessed with the use of similar and percentage responses and also with the organization of a cross-impact matrix. The cross-impact matrix was performed similarly to what was proposed by Anacleto et al. (2021), the authors describe the matrix as being the crossing of the implications among themselves through the self-perception of the interviewees. The matrix uses percentage values from 0 to 100 for each opinion exposed by the interviewees in relation to the other opinions expressed, comparing each item analyzed in relation to the influence provoked and received in the daily practices, as the higher the index, the higher the relevance and the attention to be given to the situation and problems experienced. The impact matrix generates an index of relevance and importance in the perception of the consumers and it reveals what needs attention for the best performance in the sector, according to Anacleto and Prazeres (2020) the matrix can be obtained by the equation:

$$IR = \frac{FA \times FB \times 100}{\sum SF}$$

IR= Index of relevance of the assessed situation;

FA = Indexes of received influence;

FB = Indexes of provoked influence;

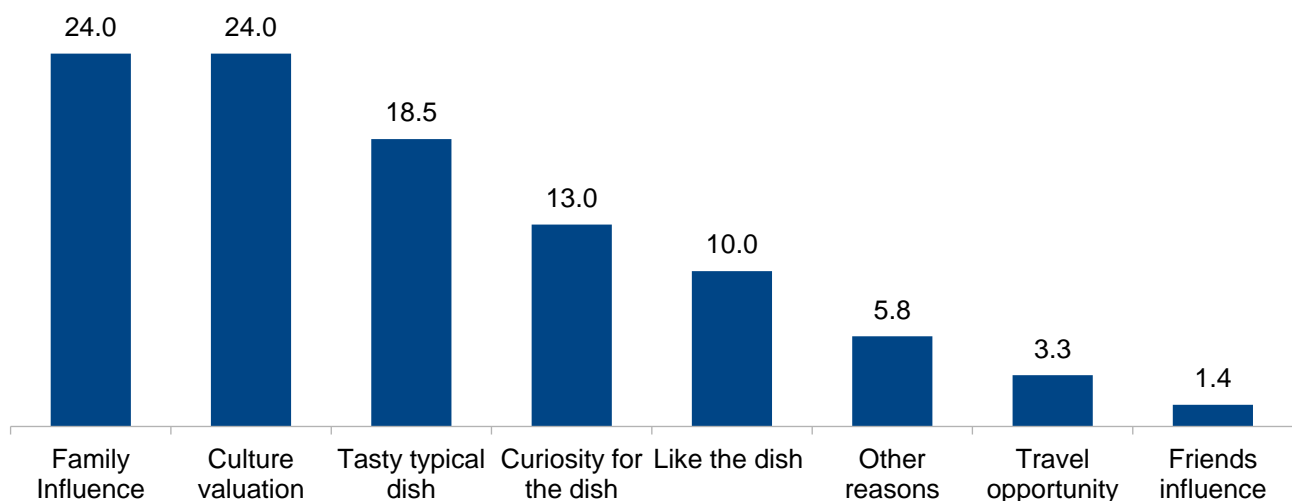
$\sum SF$ = Sum of the indexes (FA x FB) of all analyzed questions.

Finally, according to Vergara (2015), interpretative analysis was adopted, performed using the data triangulation technique with similar groupings, with the focus on classifying elements that could be perceived as similar or relatively homogeneous based on the set of questions researched, it was sought to homogenize the possible objects within the groups and simultaneously maximize the heterogeneity among the investigated group.

## 5. Results and discussion

The results of the research showed that among Barreado consumers there was a predominance of women ( $n = 61.5\%$ ). The average age was 40.9 years old. The main reasons that promoted consumption of Barreado were family influence and knowledge about the historical value and regional culture related to it (Figure 1).

Figure 1 - Factors that influenced consumption of Barreado in Paraná Coast ( $n = 151$ )



Source: The authors (2020).

The preferred places for Barreado consumption were restaurants (62%), followed by consumption in the consumers' own homes (27%), however despite a significant portion of respondents having the preference for domestic consumption, 46% of the interviewees revealed that it would facilitate consumption if they could find the delicacy in the markets near their homes, or in other commercial formats such as fairs (9%) and in the delivery system (9%).

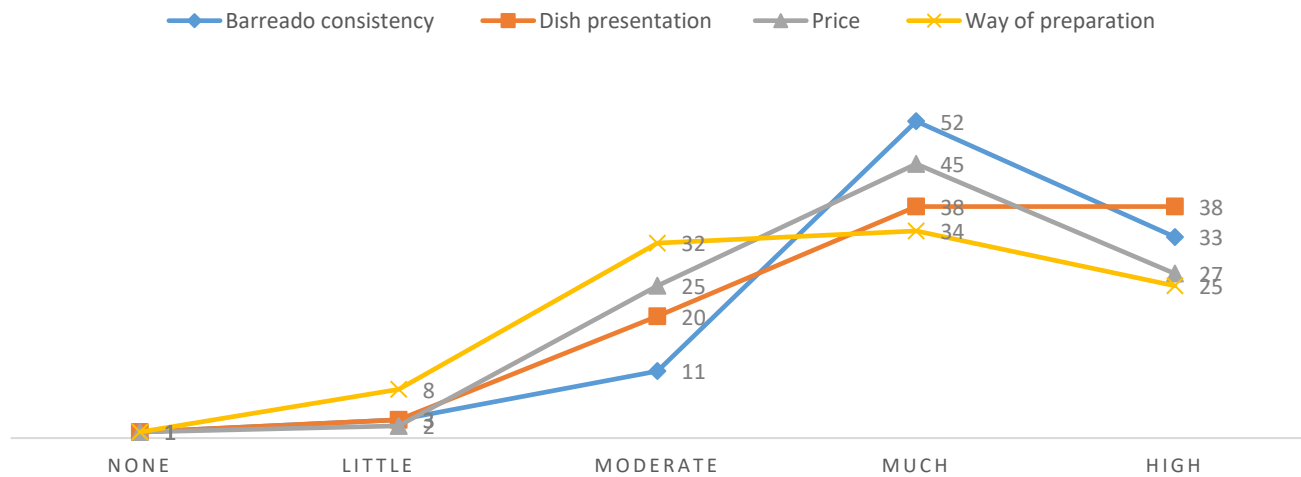
Regarding the way of preparing the dish, most respondents (46.4%) prefer to consume Barreado if it is done by the traditional way of cooking, in a clay pot and wood stove, however a significant portion of the interviewees (12.6%) still prioritize the consumption of the delicacy when it is made by the old way, which is also called *caçara*, when it is prepared in ditches with a clay pot with a sealed lid, similar to the way prepared at the time of the drovers and eaten with orange and especially with banana (58%).

The cultural relevance was corroborated in the present study when questioned, 47.68% of the respondents said to have knowledge about the history of Barreado, as well as 66% of the respondents were aware that Barreado was classified as immaterial heritage of the city of Morretes, the largest producer of Barreado in Brazil, and the same percentages of the interviewees relate the city of Morretes to the Barreado, where tourism and gastronomy are inseparable from the city image.

In relation to the product itself, the interviewees attributed concepts that reveal the level of importance related to its consistency, way of dish presentation, affordable price and the traditional way of preparation

(Figure 2), and in all cases the junction of the attributes revealed that these four requirements are decisive with regard to the possibility of consumption.

Figure 2 - Level of importance of the delicacy in the consumer's perception (n = 151)



Source: The authors (2020).

The study revealed that the consistency of the Barreado is a very important factor for the consumer, however the adequate consistency of the dish can be obtained by two factors, the first one is the quantity and quality of the cassava flour used in its preparation, it is necessary to emphasize that the Barreado consistency is closely linked to the presentation of the dish to the consumer.

The consumption is made with white (not toasted) cassava flour after cooking. The white flour is used in the preparation of a kind of mush, where over the white flour the Barreado is served in boiling broth, that is, the consumer can choose both a Barreado in a mush style, as well as a more consistent one. Mascarenhas and Ramos (2008), corroborate this statement and verified in relation to the Barreado consistency that consumers complaints in relation to the consistency of the dish reporting that it was served more broth than meat, thus the choice by consumers of the traditional establishments can represent a greater satisfaction regarding the quality of the product in the consumer's perception.

Still talking about the Barreado consistency, another relevant alternative to resolve the issue related to its consistency and that not all establishments make the correct orientation of how the flour should be made available in the dish, the way of scalding the flour with the hot broth and finally how to serve the meat, even do not they explain the reasons why the banana is served with the dish because it is a typical product of the region. In this context, a brief explanation by the waiters about the history of the Barreado and the way of preparation could increase the level of satisfaction in eating the dish and make loyal consumers. Gortz and Siqueira (2013) corroborate what was found in the present study, and report that giving the presentation on the correct way of how to eat Barreado, showing the ideal consistency and the traditional way to taste the dish, talking about the history and its origin, the possibility of success by the entrepreneur rises.

The overview on the production and trade of Barreado in Paraná Coast showed that the main implications were associated with commercial issues of price and distribution, however the potentialities such as the product has origin in Paraná and the ability to generate regional development were highlighted (Table 1).

Table 1. Diagnosis of the scenario external to the activity of Barreado production and trade in Paraná Coast in the perception of the interviewees.

Threats (implications)		IR	Opportunities (strengths)		IR
1	High price	24,14	1	Regional development alternative	16,76
2	Few product distribution locations	15,46	2	Cultural exclusivity of a regional productl	15,33
3	Organization of producers and traders in initial stage	11,09	3	Strengthening regional gastronomic tourism	14,91
4	Lack of government incentive for gastronomic tourism	10,00	4	High tourist demand in the summer time	14,91
5	Poor disclosure of Barreado in Brazil	9,06	5	Productive arrangement in the organization process	9,86
6	Variation in the preparation of the delicacy	8,71	6	Low raw material cost	9,23
7	Lack of knowledge Barreado history inhibits consumption by tourists	6,89	7	Valorization of female labor	7,35
8	Aesthetics of the dish does not always please the tourist consumer	6,89	8	Simple production technology	4,21
9	Low quality of Barreado produced by some restaurants	5,44	9	Possibility of production growth	4,21
10	Little offer of delivery service	2,32	10	Possibility of expanding the distribution to other Brazilian regions	3,23

Source: The authors (2020).

Regarding the opportunities, gastronomic tourism as an alternative for regional development apparently constituted one of the main alternatives to the Northern portion of Paraná Coast, this assumption emphasizes that through incentives to local culture, there is also an increase in the appreciation of that region that ends up boosting trade, transforming the current scenario. The development of tourism based on Barreado can promote the insertion of regional culture and history, generating jobs, income and opportunities for local people, moving the economy, enabling an increase in the income for local residents. However, it must be considered by those involved in the segment a minimum standardization of the ingredients in order to minimize the variation in the preparation of the delicacy pointed out by consumers. The cultural factors according to Kotler (2000) are those that exert the broadest and most profound influence on consumer behavior, and specifically in relation to the consumption of Barreado, the delicacy is classified as being the cultural value, therefore it is essential to understand its origin, history and forms of preparation as a tactic to strengthen the product consumption with the consumers.

According to Furtado (2004), individuals look for new possibilities of learning, information, experiences, through unknown flavors they can experience, therefore, a new culture and gastronomic style with the objective of exploring the locality in particular. In this sense, the gastronomy has a cultural value that interferes with the definition of the tourist destination.

In relation to the implications, Barreado is considered an expensive product when compared to other food offerings easily found in the region, so the price ends up limiting the possibility of increasing the levels of service to consumers, lovers and those who still are not loyal to the consumption of the dish. In this respect, two issues must be considered in relation to the price of Barreado.

The first question, despite the high price, does the consumer of Barreado have the satisfaction feeling of his need? Satisfaction according to Kotler (2000) is the feeling of pleasure or disappointment resulting from the comparison of the performance expected by the product (or result) in relation to the person's expectations. In this context, it is natural for people to make their purchases with expectations about the product performance, therefore, satisfaction is the expected result, that is, it is defined as the post-consumer assessment that the alternative chosen by the consumer met or exceeded the expectations. The consumption of Barreado among respondents met this prerogative, given that 62% of respondents had the habit of eating Barreado in restaurants, where the cost is higher than domestic consumption.

With regard to the possibility of expanding products and gaining new markets, consumers with less sensitivity to the price issue revealed difficulty in acquiring the product outside the local productive arrangement, as the product meets the needs and desires of the customers in terms of quality, so it is necessary to consider new ways of distributing the product to retail chains, including products being offered in new formats different from the traditional ones and in the frozen product shelves in the supermarkets. Thus, if the delicacy meets the consumer's taste and there is an acceptance in relation to cost, benefit and quality of the product, the second factor to be analyzed is the question of price, classified as being high when it comes to winning new customers.

The price when it is the first time of consumption or experimentation represents the main obstacle to be overcome, there is a wide range of food products that can be offered to consumers, so the cultural issue and the desire for experimentation can be limited if the scale of values used by consumers for their individual satisfaction is more strongly linked to the economic issue.

According to Porter (2004), consumers have the power to bargain with companies, forcing them to lower prices and increase the quality of the product or service offered, this can be further evidenced in local productive arrangements such as Barreado one, when dozens of establishments offering the same product, so the bargaining power of consumers can generate rivalry between competing business, forcing entrepreneurs to adhere to the requirements desired by customers in order to win them over. However, when companies try to win over this more price-sensitive class of customers, there may be a reduction in the quality of the Barreado offered, as the price reduction may result in it being impossible to meet all requirements with excellence.

Products of high value when compared to those that replace them, it has a greater commercial possibility if a focus or differentiation strategy is adopted, given that the higher price makes it possible to increase the quality of the product, thus reaching the satisfaction and requirements of the customers (PORTER, 2004). However, due to the high commercial value, the offer of a product in a well-defined geographic area and

consumption by people with less price sensitivity, suggests that the appropriate strategic positioning for the development of the activity is the focus strategy as also named by Porter (2004).

The focus is a very competitive strategic positioning, being possible to choose a restricted product line or to choose a specific segment of consumers (PORTER, 2004). Barreado is not a seasonal product, given that in addition to the summer time when consumption rises, it is also sold throughout the year, which generates stability for the traders and producers in relation to their consumers. Therefore, the focus strategy allows the sector that produces the delicacy to explore the market with an approach based on the quality of production, culture and history of the delicacy.

The ability to organize a segment can be considered a major factor in regional development based on gastronomic tourism, the low capacity for collective organization, both with regard to the organization in commercial cooperation in the promotion of the product, or even in the search for demand from the public concessions in order to obtain greater visibility, dissemination and benefits to the production and trade of the Barreado. The creation of a trade association related to this issue was registered in the municipality of Morretes, the largest producer in Brazil. This stage, although embryonic, may represent an increase in participation in the collective processes of seeking improvements, which may result in a more assertive scenario, in contrast to the current one, where the problems with production and trade should receive better treatment.

## **6. Final considerations**

The results of the research showed that among Barreado consumers there was a predominance of women ( $n = 61.5\%$ ), and the average age was 40.9 years old, and the majority of the respondents (46.4%) prefers to consume Barreado if it is done by the traditional way of cooking in a clay pot and on a wood stove for 24 hours.

The greatest potential described was the fact that Barreado is a typical product of Paraná State and it has great acceptance in gastronomic tourism, which reveals its capacity to be a source that drives to regional development, however the price considered high and the distribution in the retail trade were classified as deficient, they were identified as limiting to the development of Barreado production and trade. In this context, still on the issue of price and its relation to the consumption, it was one of the main factors identified as limiting consumption and the lack of studies on this subject, then further studies on the cost and quality relationship should be considered by researchers in new future studies.

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# Financial Literacy: What Have we Learned so Far?

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## Abstract

*The present paper explores various approaches to the development of cognitive process dimensions in financial literacy. Applying the regression model, the study has examined the strength of the relationship between the actual financial competence of 413 Brazilian's students aged 18-21, studying economic disciplines, and their school performance. The research has produced the following conclusions: (a) a weak dependence of actual skills on school performance; (b) inherently associated consequence of school performance is not corresponding to the actual financial skills; (c) a low level of financial competence in the dimensions - Remember, Understand and Apply.*

**Keywords:** Financial literacy, Cognitive process dimension, Programme for International Student Assessment.

## 1. Introduction

Financial literacy is a key element for any successful national strategy that is one capable of identifying solutions to improve the lives of the respective populations (OECD, 2016). Development of financial literacy with the emphasis on creativity is currently an important topic, being pursued by a number of researchers and teachers aiming to achieve desirable level of economic education among their students (Ebrahimi and Jahnian, 2014; Puryear, 2016; Lucas, 2016). There are several reasons for the above trend; nevertheless, the most significant cause is the ever-increasing likelihood of young people facing higher financial risks, due to more frequent breakdowns of socioeconomic systems worldwide. This phenomenon is caused by increased life expectancy, reduced prosperity, uncertain economic situation overall and thus, greater responsibility for many economic decisions. Individuals may face the necessity of making their own financial decisions while choosing their future education and its financing at a relatively young age (about 15-16 years old) (OECD, 2016).

In order to increase the level of financial literacy among young people in particular, there has been an increase in the number of countries participating in PISA (Programme for International Student Assessment), implemented by the OECD within the context of its research activities at all continents worldwide. It sets out to measure the level of financial literacy among fifteen-year- old pupils who are in their final year of compulsory education. Brazil also participates in the PISA programme and through its

National Strategy it created a financial educational system seeking to increase the level of financial literacy among the citizens of Brazil, reflecting the changing demand of the financial market development and the learning needs of the students.

The objective of this research study is to determine the strength of the relationship between the actual financial competencies of 413 18-21-year-old Brazilian students studying economic disciplines and their current school performance. Based on the regression model, this analysis will prove or disprove the existence of the relationship between success at school and the actual skill defined by the cognitive dimensions - Remember, Understand and Apply. In other words, we strive to find out whether it is justified to assess the level of financial literacy among students by applying the criterion of the acquired school assessment grading, which is a popular aspect of the Brazilian educational system. This finding is conditional upon proving the instability of the relationship between the variables, which was significantly verified in several independent foreign studies (Little et al., 2003; Kiliyanni and Sivaraman, 2016). Otherwise, it will be obvious that the level of financial literacy can be significantly strengthened by work experience, a cognitive approach to learning, age and other factors, as it was substantiated by foreign studies. For the reason of the defined size, the article does not focus on proving all of the major factors affecting the level of financial literacy in the study sample.

## **2. Background**

In Brazil, the National Strategy for Financial Education was established in 2010 and is led by a committee composed of eight government agencies (including the central bank, the ministry of finance and the ministry of education) and four financial industry associations. The national strategy includes a financial education programme in school, which was initially developed for high schools in 2010-11 and is now being extended to primary schools.

A growing number of studies assess the impact of programmes offering financial education in schools, as part of the curriculum or as pilot projects. In particular, some experimental studies on secondary school students have assessed the extent to which financial literacy can be improved through formal financial education by focusing on random assignments to financial education in school. A number of recent meta-analyses have shown substantial heterogeneity in the ability of different programmes to improve financial knowledge and skills (Fernandes et al., 2014; Miller et al., 2015; Kaiser and Menkhoff, 2016). Despite the growing number of evaluation studies, however, the evidence base of rigorously evaluated financial education programmes targeting specifically students in school is not large yet, making it difficult to draw general conclusions on which programme features, teaching materials or teaching methods are the most effective, and calling for further evidence to know which approaches work best.

Financial education was initially introduced in Brazilian high schools through a pilot in 2010-11 over 800 schools in six states (Bruhn et al., 2016). The pilot involved preparing a financial education curriculum, developed by a team of education experts, psychologists and sociologists. The content included innovative material designed to capture the interest of young adults and to be relevant to their lives. It consisted of case studies that can be integrated into regular school subjects, such as mathematics, Portuguese, science,

geography and history. Teacher guidelines explain how to integrate these case studies into the regular curriculum, and teachers have discretion over the order in which the cases are taught. Teachers were trained through workshops, DVDs and a guidebook. The material developed for the pilot is now available on line to all teachers across the country.<sup>3</sup> Teachers have full autonomy whether to use this material and integrate elements of financial education into their courses. A pilot for primary schools is being developed in 2020.

Measuring of the level of financial literacy among students under the PISA 2015 international survey (OECD, 2017) focuses on four content categories (1 - Money and Transactions; 2 - Planning and Management of Finances; 3 - Risk and Reward; 4 - Financial Landscape). A total of 15 countries worldwide took part in the survey, with 64,392 schools, i.e. 23,141 students, participating in Brazil. Results can be pivotal for the future of the country, as they reflect whether young people have the tools necessary to be financially critical and responsible. That is why it is important to pay special attention to this assessment when defining educational plans, to correct shortcomings and boost the virtues of each country's education systems. Due to the methodology of the assessment itself, results allow to perform an international evaluation of the literacy of young students in finance-related topics, and compare the financial education levels between countries in order to identify best practices and the most effective national strategies.

Referring to the research work of the foreign scientists Kiliyanni and Sivaraman (2016) and our previous empirical studies, the weak correlation relationship between the actual cognitive skills of students and school performance is caused by the influence of the learning process facilitator and his/her method of encouraging students to search for deeper understanding. Students with better academic achievements often lack a deep- thought process, are unable to search for links, connections or structures and join them into a single whole compared to those students whose school performance is weak. The reason for this situation is the prevailing surface style of learning that develops only the basic dimension of the cognitive process — the level of learning information by rote and its subsequent reproduction (Taylor and Klein, 1998). This phenomenon can be gradually eliminated by devoting greater care to the development of creative thinking through epistemological processes and methods used in economic science.

The application of procedures aimed at developing creative thinking in economic science and education is facilitated by the conceptual model of the Higher-Order Cognitive Skills (HOCS) that represents the epistemological process of thinking development in science, technology, environment, society, economy and policy (STESSEP) education, as well as activity and creativity development (Zoller, 2015, p. 4.476). By applying this model it is possible to create higher-order cognitive skills - question asking, system-, critical- and evaluative thinking, problem solving, decision making as well as moral thinking, creative thinking and transfer. The model is very closely connected with the revised Bloom's taxonomy of cognitive dimensions (Anderson et al., 2001), which is its predecessor and allows identification of 6 dimensions of cognitive process (learning objective), i.e. Remember, Understand, Apply, Analyze, Evaluate and Create.

According to Tetteh and Sarpong (2015), for the positive development of the student achievements it is optimal to use an active learning strategy. By applying this strategy we develop in students the highest Knowledge Dimension - Metacognitive Knowledge and the highest Cognitive Process Dimension –

Creativity. This issue concentrating on the increase in creativity and innovation in the context of development of education for entrepreneurship has been examined by Krpálek and Krpálková Krelová (2016). Proceeding from empirical research the authors present recommendations for development of education for entrepreneurship focusing on creativity and innovation at all levels of education and vocational training. Bernat et al. (2009) dealt with students' entrepreneurship skills at the universities in six selected post-socialist countries, namely Lithuania, Latvia, Poland, Ukraine, Russia, and Hungary.

Belas et al. (2016) proposed to create more room for increased use of modern teaching methods in order to improve application skills of students. In this context, it is necessary to focus on the use of modern methods that promote creativity and initiative of students (case studies, problems solution method and brainstorming). The current method of teaching traditionally focused on gaining of encyclopaedic knowledge, that can be more use full in the knowledge competition, than the real life.

Creative thinking holds an important position in economic education. It is one of the prerequisites guaranteeing the effective and sustainable acquisition of new knowledge and its subsequent deepening with full comprehension. This idea is at the centre of attention of the Indonesian teacher and researcher Subroto (2015), who examined cognitive approaches to development of creative thinking in students of economic disciplines. His research confirmed that the higher professional specialisation of students could be ensured through the development of creative thinking. The acquisition of deeper and meaningful sustainable knowledge can be achieved by reviewing the economic educational content which will be presented with the help of such strategies that will lead to the development of creative thinking (Zoller, 2015).

In the economic interpretation of phenomena, one may apply the general economic methodology. Based on their significance, Jurečka et al. (2013, p. 25) includes, among the methods used in economics, (a) abstraction allowing differentiation between essential and unimportant elements and preparation of the object of research for analysis; (b) analysis; (c) synthesis; (d) induction; (e) deduction; (f) modelling; (g) observation of economic reality; (h) experiment enabling studying the phenomena of the real world under supervised and controlled conditions. These methods play an important part in the development of cognitive dimensions in relation to thinking. In this way it is subsequently possible to achieve singular dimensions of cognitive processes in individuals up to the level of creative thinking.

The links among economics, thinking and the deduction of correct conclusions were commented on by the prominent English economist J. M. Keynes: "Economics is an apparatus of the mind, a technique of thinking which helps its possessor to draw correct conclusions" (e.g., Jurečka et al., 2013, p. 19). Therefore, it can be noted that the properly selected strategy influences school performance. The same conclusions were arrived at by Eren and Coskun (2016); Cheung and Jhaveri (2016).

### **3. Methodology**

#### **3.1 Theoretical Concept**

The theoretical foundation of the research is the revised version of Bloom's two-dimensional taxonomy

(Anderson et al., 2001), defining cognitive processes according to their difficulty. The cognitive process dimensions, considered relevant for this research study, are defined as follows (Anderson et al., 2001, p. 31):

- 1. Remember** (Retrieve relevant knowledge from long-term memory; typical verbs are identify, define, add, label, specify, visualize);
- 2. Understand** (Construct meaning from instructional messages, including oral, written, and graphic communication; typical verbs are explain, seek, interpret, calculate, summarize);
- 3. Apply** (Carry out or use a procedure in a given situation; typical verbs are apply, demonstrate, discuss, explain, show);
- 4. Analyze** (Break material into constituent parts and determine how the parts relate to one another and to an overall structure or purpose; typical verbs are find the principle of arrangement, split into sub-elements, decide, explain relationships, find a solution);
- 5. Evaluate** (Make judgments based on criteria and standards; typical verbs are to argue, defend, oppose, support opinions, give critique, judge, assess, justify);
- 6. Create** (Put elements together to form a coherent or functional whole, reorganize elements into a new pattern or structure; typical verbs are categorize, combine, modify, suggest, summarize, draw conclusions, organize, reorganize).

The objective of the research is to determine the causal relationship between the school performance of 18-21 year-old students and their actual cognitive skills relating to financial issues and on this basis to propose a methodology for the development of the cognitive process dimensions. The research task focuses on the cognitive dimensions - Remember, Understand and Apply. Higher-order cognitive dimensions are not included, as they were not being developed in these students in the course of the learning process. Yet the recommendations also pay attention to the methodology for higher-order dimension development, for the ability to analyze, solve problems of financial matters on a short term basis and draw correct conclusions while engaging the creative thinking of an individual was identified by the OECD survey (2017). The hypotheses below are to be tested in relation to the objective, namely:

- **Hypothesis 1:** *The level of cognitive dimension – Remember depends on study performance.*
- **Hypothesis 2:** *The level of cognitive dimension – Understand depends on study performance.*
- **Hypothesis 3:** *The level of cognitive dimension – Apply depends on study performance.*

Table 1. Structure of respondents according to school performance in the Accounting Subject

Grade	Absolute Frequency	Relative Frequency
1 – Excellent	49	11.9%
2- Very Good	106	25.7%
3- Good	125	30.3%
4- Sufficient	120	28.9%
5 – Insufficient	13	3.2%
<b>Total</b>	<b>413</b>	<b>100%</b>

Authors' results.



The data were analyzed with the support of the NCSS statistical software (2020 version) on the basis of mathematical statistical methods. Testing of null hypotheses was carried out at a 5% level of significance using the linear regression model through a regression t-test of parameters and an F-test of the model. The linear regression model was chosen both for the satisfactory character of the variables and for revealing of the unilateral dependence of the variables, when the independent variable - explanatory variable (grade) stands against the dependent one - explained variable (real financial skills). For the reason of demonstration, if school requirements form financial skills (consequence) in the form of grades (cause), other control variables (gender control, residence, socio-economic background) were not included in the model.

The data were collected applying the method of achievement tests, which identified the actual level of the financial skills of students on the level of individual cognitive process dimensions. Students were to show their specialist knowledge and skills of the financial (economic - accounting) issues that covered the extent of topics taught so far. Stretching over two teaching units, the achievement test was to check (a) the Remember dimension via a set of theoretical questions; (b) the Understand dimension by way of solving practical economic situations; (c) the Apply dimension, again by way of solving practical economic situations with greater emphasis placed on the ability of abstraction, deduction and induction. (The content of the examined dimensions and number of tasks within the individual dimensions are listed in Table 2; each issue is identified by a number).

Table 2. Content of tasks and their number in individual cognitive process dimensions

<b>Cognitive Process Dimension</b>	<b>Number of tasks</b>	<b>Number of areas covered in the tasks</b>
Remember	11	(1) Entrepreneurship; (2) Ownership and capital structure; (3) Balance Sheet; (4) Valuation of assets; (5) Tax system; (6) Legal system of Brazil; (7) Latin America;
Understand	13	(8) Money and financial markets; (9) Accrued and deferred costs and revenues, (10) Accrual principle, (11) Balance Sheet; (12) Real-life accounting cases and their impact on the accounting books; (13) Determination of production capacity; (14) Relationship between a company and a revenue authority in terms of value added tax; (15) Charging interest;
Apply	9	(16) Value added tax in a retail chain; (17) Fixed and variable costs and price calculation; (18) Application of the accrual principle for the accrued and deferred costs and revenues with the impact on the profit or loss in different periods; (19) Financial evaluation of the situation and company performance efficiency as depicted by accounting reports.

Authors' results.

Questions and numerical problem-solving tasks were assigned in a way other than the students were used to from their lessons in order to establish whether the students were able to depart from the common procedures taught, whether they were able to use deduction and place elements in context and in an integral whole while engaging logical, abstract thinking in the financial sphere.

As to their content, achievement tests correspond to Category Two of the PISA 2015 Survey (OECD, 2017) aimed at measuring the level of financial literacy. (Let us mention once again that Category Two deals with the issues of asset and capital structure management, cash flow management and finding ways to improve one's own financial situation.)

The independent variable is the school performance (academic grade) in the Accounting Subject. The dependent quantitative variable is the real financial skill found through the point score that students have gained as an aggregate of both tests. The purpose of these variables' direction is to find out if a level of financial literacy can be explained by a grade. In other words if school requirements form students' financial skills expressed by the grades, and it is therefore desirable to consider the classification of those skills that represent a recognized OECD framework. Thus, a grade was chosen as an independent variable in a simple regression model, and the real financial skill was chosen as the dependent variable.

For the purpose of testing the hypotheses applying the mathematical statistical methods, the null hypothesis claims that there is no dependence between the variables. The null hypotheses and alternative hypotheses have been formulated as follows:

$$H_{0-1}: \beta_i = 0$$

*The level of the cognitive dimension - Remember is not dependant on school performance.*

$$H_{1-1}: \text{non } H_{0-1}$$

$$H_{0-2}: \beta_i = 0$$

*The level of the cognitive dimension - Understand is not dependant on school performance.*

$$H_{1-2}: \text{non } H_{0-2}$$

$$H_{0-3}: \beta_i = 0$$

*The level of the cognitive dimension - Apply is not dependant on school performance.*

$$H_{1-3}: \text{non } H_{0-3}$$

The normality of the quantitative data was checked with several statistical tests that verify the assumption of a normal distribution of data (Shapiro Wilk & Anderson Darling D'Agostino; Skewness D'Agostino; Kurtosis D'Agostino Omnibus). The reliability of the test increases with the quantity of the measurements ( $n > 100$ ). Our research complies with this condition. The distribution of the data was further checked by the Exploratory Data Analysis (Probability Plots). A linear regression model was set up for the rejection or non-rejection of the null hypotheses with a significance level  $\alpha = 5\%$ . The null hypothesis will be rejected if  $\alpha > P\text{-Value}$ . Applying the method of least squares, regression coefficients (parameters)  $b_0$  and  $b_1$  will be estimated, where  $b_0$  represents a constant (*Y-intercept*) and  $b_1$  denotes the average change in the dependent variable  $y$  for a 1-unit change in the independent variable  $x$ . In this way it is possible to determine the strongest or weakest dependence of the dependent variable on the independent variable as well as positive linear relationship (+) or negative linear relationship (-). The value of the correlation coefficient  $R^2$  is taken into consideration in the model as it denotes the strength of the relationship.

The application of the linear regression analysis provides the quantification of the dependence of the variable  $y$  (the points scored corresponding to the level of actual financial skills) on the independent variable  $x$  that denotes school performance in the Accounting Subject.

On the basis of a sample comprising 413 observations an estimate of an empirical function will be made using the following parameters. In mathematical terms, the linear regression model can be written as the equation below (Draper & Smith, 1998; Weiss, 2012):

$$Y = f(x; b_0, b_1) \quad (1)$$

where:  $b_0$  is a constant,  $b_1$  is the estimate of the theoretical regression coefficient  $\beta_1$ .

The estimate of the theoretical regression function, which is in the form of a regression line, can be expressed as:

$$Y_i = b_0 + b_1 x_i \quad (2)$$

provided that the assumptions of the classical linear model are met.

## 4. Discussion

The level of the financial competence of Brazilian students aged 18-21 is considerably low. The average points scored converted to a success rate in the test come to 48.2%. Weak performances have been recorded at the level of remembering and applying the theory in specific economic situations. (In the dimension - Remember the score amounts to 51%; in the dimension - Understand to 57.9% and in the dimension - Apply to 25.7%.) Students have difficulty using economic methods such as abstraction, deduction and induction. Even the lowest ability of mere memorization (remembering) of the acquired knowledge is at a poor level. The students have the best grasp of the issues relating to entrepreneurship, recording real-life cases in accounting books, the tax system with an emphasis on determining the relationship with the revenue authority in terms of value added tax in a retail chain, the Brazilian system of law (Code Law), and they are able to understand the accrual principle. As to other researched areas, (see Table 2), the students have shown significant inadequacies. They are very weak in their ability to apply specialist theoretical knowledge in solving specific economic situations.

### 4.1 Relationship between school performance and actual cognitive skills

The school performance assessed on the basis of the six-month school activities of students is compared with the actual performance (points scored) within an individual cognitive dimension established in real time. Performance in the achievement test by students divided according to their academic grading was converted to assessment grades applying the standardized rules used in the Brazilian schooling system. This comparison identified the reversed trend between school performance and the actual skill determined by the cognitive process dimension (see Table 3).

Table 3. Structure of respondents according to school performance in the Accounting Subject

Academic grading in the given subject	Performance in the dimension - Remember	Performance in the dimension - Understand	Performance in the dimension - Apply	Performance in all dimensions	Academic grading reflecting the actual skill
1 <1-0.9>	0.565	0.692	0.408	0.555	4
2 <0.89-0.75>	0.522	0.618	0.280	0.473	5
3 <0.74 – 0.6>	0.532	0.577	0.242	0.450	5
4 <0.59 – 0.5>	0.455	0.509	0.202	0.389	5
5 <0.49 – 0>	0.481	0.513	0.141	0.378	5

Authors' results.

The achievement test included exercises with the actual tasks worded in a way other than the students were used to from their lessons in order to establish whether the students were able to depart from the common procedures taught and to what degree they were able to make use of abstract-visual and financial thinking. The results suggest a significant reversed trend between school performance in the Accounting Subject and the actual cognitive skills of students assessed in the Accounting Subject with the grades 1- Excellent and 2-Very Good. According to the evaluation of cognitive skills these students go down by 3 to 4 grades in real terms. Cognitive skills of students with a worse school performance (grades 3–Good to 5- Insufficient) correspond more to their school achievements in the given subject. However, it should be noted that there was a marginal number of students placed under the grades 3–Good to 5-Insufficient with test scores which would corresponded to the score of an excellent student. Nonetheless, with the 5% level of significance this relationship has not been statistically proven.

#### 4.2 Normality of data

The normality of the data (see Table 4) was analyzed at a 5% level of significance, but it was verified only by one (D'Agostino Kurtosis test) out of the total of five used tests (the others being Shapiro Wilk, Anderson Darling, D'Agostino Skewness, D'Agostino Omnibus).

Table 4. Normality of the analyzed data

Test	T-value	Prob Level	Reject 5%
Shapiro Wilk	0.9918	0.115899	No
Anderson Darling	0.6545	0.087621	No
D'Agostino Skewness	-1.7732	0.076190	No
D'Agostino Kurtosis	0.9840	0.325094	Yes
D'Agostino Omnibus	4.1127	0.127920	No

Source: Authors with the help of the NCSS program (version 2020).

The data distribution was tested with the Exploratory Analysis that ascertained the level at which the distribution of the sample data approaches the normal distribution. The Exploratory Analysis has verified that the data have not departed too far from the straight line (in the middle), which can be considered a

borderline result. In conclusion it can be stated that the input data are correct for a subsequent analysis.

### 4.3 Linear regression analysis $H_{0-1}$ - $H_{0-3}$

The method of linear regression analysis has been applied to test the influence of the school performance on the level of cognitive process dimensions (Remember, Understand, and Apply). In the interpretation of the regression model, it should be kept in mind that increasing the grade in the form of an increase in the quantitative variable (1-5) actually means worsening (decrease) in school results and decreasing of the grade in the form of a decrease of the quantitative variable (1-5) means improvement (increase) of school results in the model.

Therefore, based on this logic, the results of all three regressions are interpreted. For each relationship a regression model was set up and the regression coefficients were evaluated (see Table 5).

Table 5. Linear Regression H0-1

Variables	Regression Coefficient $b_i$	Standard Error $Sb_i$	T-Value	Prob Level	Reject $H_0$ at 5 %
Intercept $b_0$	0.5956	0.0342	17.4031	0.0000	Yes
Grade $b_1$	-0.0301	0.0112	-2.6770	0.0079	Yes

Source: Authors with the help of the NCSS program (version 2020).

With 95% test reliability, one may argue that there is a negative relationship between the dimension based on remembering financial issues and school performance ( $P = 0.0079$ ). The regression model of the linear relationship can be written for  $n = 413$  as follows:

$$Y_i = 0.5956 - 0.0301x_i \quad (3)$$

If the grade increases by 1 unit (i.e. if the school results get worse), the score describing the level of financial skills in the dimension Remember decreases by an average of 0.03 points. Verification of the  $H_{0-2}$  is illustrated in Table 6.

Table 6. Linear Regression H0-2

Variables	Regression Coefficient $b_i$	Standard Error $Sb_i$	T-Value	Prob Level	Reject $H_0$ at 5 %
Intercept $b_0$	0.7344	0.0295	24.9205	0.0000	Yes
Grade $b_1$	-0.0542	0.0097	-5.6094	0.0000	Yes

Source: Authors with the help of the NCSS program (version 2020).

With 95% test reliability, one may argue that there is a negative relationship between the dimension based on understanding and school performance ( $P < 0.01$ ). The regression model of the linear relationship can be written for  $n = 413$  as follows:

$$Y_i = 0.7344 - 0.0542x_i \quad (4)$$

If the grade increases by 1 unit (i.e. if the school results get worse), the score describing the level of financial skills in the dimension Understand decreases by an average of 0.054 points. Verification of the H0-3 is illustrated in Table 7).

Table 7. Linear Regression H0-3

Variables	Regression Coefficient $b_i$	Standard Error $Sb_i$	T-Value	Prob Level	Reject $H_0$ at 5 %
Intercept $b_0$	0.4220	0.0368	11.4794	<b>0.0000</b>	Yes
Grade $b_1$	-0.0578	0.00121	-4.7900	0.0000	Yes

Source: Authors with the help of the NCSS program (version 2020).

With 95% test reliability, one may argue that there is a negative relationship between the dimension based on application and school performance ( $P < 0.01$ ). The regression model of the linear relationship can be written for  $n = 413$  as follows:

$$Y_i = 0.4220 - 0.0578x_i \quad (5)$$

If the grade increases by 1 unit (i.e. if the school results get worse), the score describing the level of financial skills in the dimension Apply decreases by an average of 0.058 points.

**It may be concluded that at the 5% level of significance we reject  $H_{0-1}$ ;  $H_{0-2}$ ;  $H_{0-3}$ .**

## 5. Conclusion

Research has proven that requirements placed on students in the form of grades affect real financial skills and thus determine students' financial literacy. However, the values of the partial regression coefficients are low despite the proven dependence.

The school performance of the students is evidently influenced by other important factors, which have not been included in the model but which have been substantiated by other previous research activities. These include the cognitive approach of the learning process facilitator as well as students' work and practical experience that support the learning of the theory and its transferability into real-life situations in a more efficient manner. However, their analysis is not the objective of this article, but considerable attention will be paid to them in the forthcoming research. One must note that the school performance has a greater influence on the dimension – Apply than on Understand and Remember. Nevertheless, these differences are marginal and insignificant. In the development of financial literacy, logical thinking is the lynchpin for the functioning of cognitive processes in learning. It can be quite easily developed in mathematical disciplines that are the basis for economic science.

This can be achieved proceeding from the proven relationship between mathematical and financial literacy,

which was verified mostly in another developed countries individuals (OECD, 2017). Therefore, it is desirable that mathematical abilities are more supported in this study group of 18-21 year- old Brazilian students. Thanks to the mathematical competence, students will be able to use higher levels of epistemological processes in economic science, strongly determined by the methods of abstraction, analysis, synthesis, induction and deduction (Jurečka et al., 2013). In order to move the cognitive process towards the higher orders of its dimensions (Analyze, Evaluate, Create) the presence of economic methods in education is desirable. This fact was known even by J. M. Keynes, who perceived economics as an apparatus of the mind helping us to draw correct conclusions, relevant in relation to the studied economic problem.

Consequently, let us take a look at the possible approaches of how the cognitive process can be moved via economic methods into its higher-order dimensions up to the level of creative, financial thinking, provided that the individual has mastered the theory with a sufficient level of understanding. At this stage, it is already possible to focus on the dimensions - Apply, Analyze, Evaluate and Create. In economic science the process of the advancement into higher orders of cognitive dimensions was very well illustrated by Zoller (2015) with his HOCS model, whose efficiency has been demonstrated by a number of indicators (a) question asking, (b) system-, critical- and evaluative thinking, (c) problem solving, (d) decision making as well as moral thinking, (e) transfer. By applying this model in practice it is possible to guarantee a higher level of actual financial competence in an individual. This is brought about by the option of demonstrating economic problems and their solutions directly from real-life situations. Kiliyanni and Sivaraman (2016) established that practical experience, a cognitive approach to the study and the possibility of deeper knowledge rank among significant factors with a positive impact on the level of actual financial competence.

Nonetheless, the level of financial competence does not entirely reflect the school performance of Brazilian students. A similar situation has also been identified in the United States, where a very low correlation between study results and the actual ability of the student was proven (Little et al., 2003). By contrast, in Japan and Germany a very strong causal relationship was substantiated. Therefore, it is desirable to prospectively deal with the causes of the instability of the relationship between variables in different countries worldwide.

Despite the results of the PISA 2015 Survey (OECD, 2017), showing an below-average level of financial literacy of the Brazilian fifteen year-old individuals in issues relating to finance, finance management, risk and reward management as well as the financial landscape, the results of this study have presented a rather sceptical view of their further development and sustainability during the study of economic disciplines with respect to students of 18-21 years of age. At the same time the school performance (i.e. the efforts of the students) is not a major factor influencing their actual financial skills, measured by various cognitive process dimensions. A weak relationship has been proven between the variables.

As the article aimed to determine the strength of the relationship between success at school and real skills, and not just to multi-dimensionally analyze the factors influencing the actual financial (cognitive) skills of individuals, the study has produced, in terms of the development of the cognitive process dimensions with



the application of economic methods, the following practical conclusions that can be summarized as follows:

- The study of economic disciplines by individuals aged 18-21 in Brazil does not guarantee the level of financial literacy that should correspond to such a type of study. The sustainability of the underlying assumptions and their progressive development are also not ensured.
- Inadequacies are apparent in Category No. 2 of financial literacy, i.e. in the ability to plan and manage finances with a closer focus on the asset and capital structure management, cash flow management and finding ways to improve one's own financial situation.
- The interpretation of the regression model revealed surprising relationships within the structure of the respondents, divided according to their school performance in the Accounting Subject which allows adequate development of financial competence in an integrating manner. A reverse trend in the relationship between the study performance and the actual skills has been identified, where the financial skills of students with grades 1-Excellent, reflecting not only a half-year of their work and effort, are at the actual level of the assessment grade 4-Sufficient. (Skills of grade 2-Very Good students correspond in real terms to grade 5-Insufficient.) There is a marginal group of students placed under the grades 4-Sufficient and 5-Insufficient whose actual skills match the grades 1- Excellent or 2-Very Good. These relationships have revealed that it is necessary to enhance the level of student financial competence in real terms in ways other than by placing the emphasis on encyclopaedism and memorization of knowledge, which is so well-spread in Brazil.
- The proven low level of financial competence in the cognitive process dimensions of remembering, understanding and application of theory in solving practical economic situations speaks volumes about the future necessity to devote much greater attention to the tried and trusted methods of economics in the process of learning.

In an attempt to develop financial competence in higher-order dimensions of the cognitive process, it is desirable to transfer economic methods from theory to the practical application in the learning process. This will ensure a better preparedness of the young generation to survive in an every-day economic world, also thanks to the transfer of foreign practices to Brazilian conditions.

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## **“They Don't Play in Service”: Analysis of Female Work in the Context of Red Ceramic Production**

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**Abstract**

*The production of red ceramics (tiles and bricks) was an important activity for the economic development of the municipality of Morro da Fumaça, state of Santa Catarina, Brazil from the 1960s onwards. This segment was a major contributor to the introduction of labor female labor in the local economy. The activity still has great economic relevance for the municipality, since it is a source of tax collection and generation of direct and indirect jobs, for a representative portion of the population. This study aims to narrate the way in which the production and development of red ceramic production took place in the municipality of Morro da Fumaça, south of Santa Catarina, Brazil, confronting it with the social reality of the actors that make up the productive force sector, especially female workers. From the female performance, analyze the working conditions to which they were submitted. Such conditions, at times, imposed a double working day in the activity of ceramic production, work in a family nucleus with the inclusion of minor workers, in addition to the responsibilities with domestic chores.*

**Keywords:** Economy; Production; Job; Working Women.

**1. Introduction**

The act of transforming the burnt clay into useful objects on a daily basis is a practice that recalls prehistory (COOPER, 1987; NAVARRO, 2006). This know-how has improved over time, being incorporated beyond survival, as a cultural reference for a people (PADILHA, 2007). Homes that were previously temporary, have gained security and strength with the use of burnt bricks (ISAIA, 2007). The oldest dates for major works using burnt bricks date back to 700 BC (SINDICER, 2005), following an evolutionary process, but still artisan until the 18th century, when with the Industrial Revolution, a leap in quality took place. and quantity in the industrial manufacture of ceramic bricks (FLORENZANO, 2016, p. 03).

The word ceramics is derived from the Greek "kermamos" which refers to something made of earth "or" burnt thing "and is used in reference to inorganic materials, originating from non-metallic compounds (CALLISTER, 1991), which are solidified by burning (OLIVEIRA, 2008). Nowadays it takes on a broad meaning, ranging from the manufacture of baked clay objects, the raw material, the product itself, to the place of production of such products (SILVA, 2016). The red ceramics, commonly produced in pottery, are named as a result of the reddish color, acquired after the firing process, as a result of the high levels of iron compounds present in the raw material (ISAIA, 2007).

The brickworks appeared in the municipality of Morro da Fumaça at the beginning of the 20th century, gaining prominence in the national economy in the 1960s, due to the industrialization process that Brazil was going through at the time. The brick as a fundamental element of civil construction, became a product

required in that context. The raw material for its manufacture, abundant in the region, was one of the motivations that led to its unbridled exploration (CARIO; PINTO JUNIOR; FERNANDES, 2008).

The workforce for the production in the pottery did not need to be qualified, which is why many entrepreneurs hired entire families, usually from jobs considered subordinate or seasonal, such as those derived from fishing and agriculture. In this logic, women, as well as other members of the family, were introduced to the body of workers and they were assigned the most varied functions within the production process.

Taking into account this theme, we have outlined a study in which reflections are developed about the presence of women in the context of pottery, within the production process and also outside it. The article is not limited to presenting the ceramic worker as a commodity, or only as a labor force, on the contrary, it seeks to present her as a human being, active subject, woman, mother and worker, who lives and has her social relations in the environment work and out of it, which makes history and at the same time is part of one. Since the beginning of the 20th century, "female emancipation" has been seen as being modest, even though a small - but unprecedented - number of active women was produced in this period, in fields hitherto restricted exclusively to men and where in fact they distinguished notably (HOBBSBAWM, 2005). This supposed "emancipation", was initially given by the middle layers of society, especially those that were located in Europe and were part of the bourgeois class. In the simplest layers, this "revolution" was felt later, slowly and gradually. Analyzing this situation, we can understand that women coming from less favorable situations already practiced the progressive act of work, however, it happened out of necessity, and was not characterized by emancipation, much less was recognized.

This study aims to unveil the way in which the implantation and development of red ceramic production took place in the municipality of Morro da Fumaça, south of Santa Catarina, Brazil, as well as the strategies used for its development, identifying in this process the introduction of workers to the industrial space, especially female workers.

## **2. Location and Characterization of the Study Area**

The municipality of Morro da Fumaça, located in the extreme south of Santa Catarina (Figure 1) is part of AMREC (Association of Municipalities in the Carboniferous Region). The Catarinense Carboniferous Region (RCC) stands out, nationally as a major producer of mineral coal, also standing out in relation to clay mining, a raw material used mainly by ceramic companies and potteries in the region, for the production of red ceramics and coatings (DNPM, 2001; CORRÊA et al., 2019). Currently, there is great economic diversity in the municipality, such as the presence of packaging companies, production of machinery and textiles, ceramic industries, with the production of bricks, clothing, rice agribusiness, extraction of clay and sand for civil construction (IBGE, 2019).

Both clay mining and its use in the ceramics and pottery industry cause damage to the environment, with mining done in open pit processes, which results in the suppression of vegetation, removal of the soil's fertile layer and exposure of the soil to erosive processes. (MECHI; SANCHES, 2010; PORTELA; GOMES, 2005). These activities have harmful effects on the balance of ecosystems, they also cause changes in the landscape that lead to discomfort in the environment of humans and other organisms that



live there (MECHI; SANCHES, 2010; CORRÊA et al, 2019).

In addition to the environmental impacts generated by the undeveloped exploitation of raw materials for pottery manufacturing, in the industrial production process, various fuels, including fossils such as coal, are burned for the cooking of ceramic pieces. This burning causes the release of a series of air pollutants, among which are particulate matter, nitrogen oxides, sulfur oxides, carbon monoxide (SILVA et al., 2012), which cause several respiratory comorbidities, both in workers, as well as in the resident population close to the production units (ALLIN et al., 2014)

The municipality is home to an estimated population of 18,000 inhabitants, whose demographic density is 194 ha / km<sup>2</sup> (IBGE, 2019).

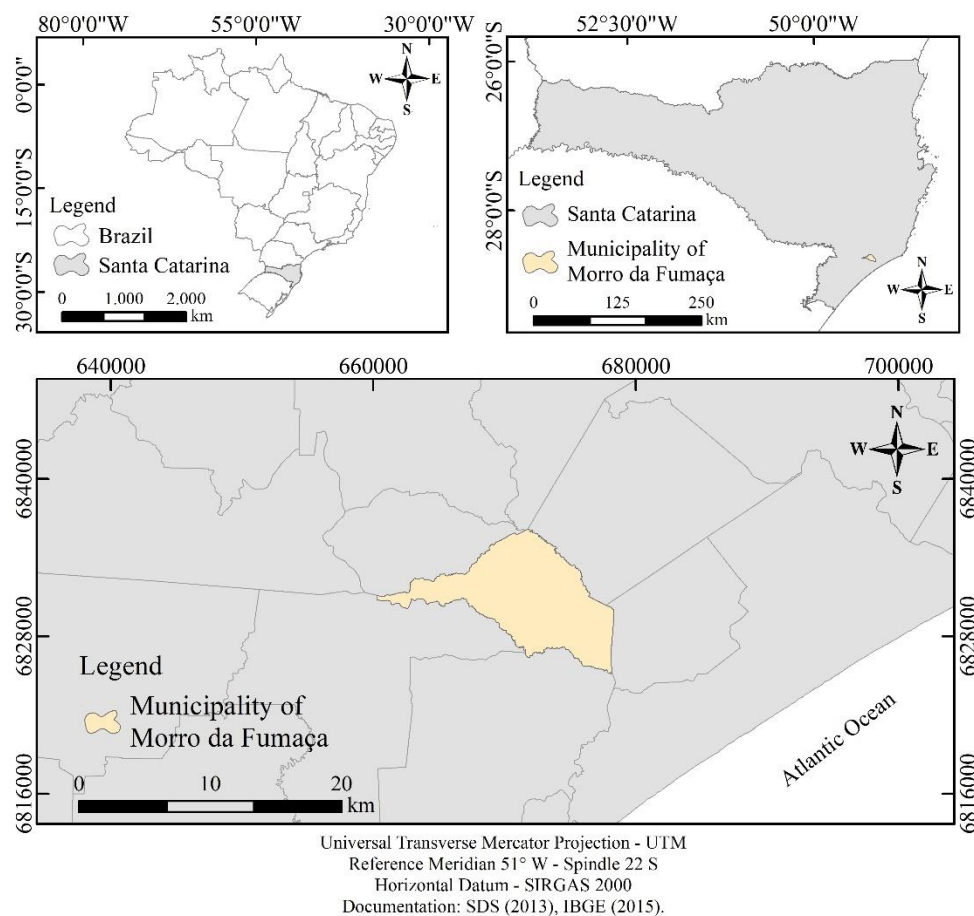


Figure 1 – Geographic location of the municipality of Morro da Fumaça - SC

Source: Authors (2020)

The first potteries appeared in the city between the 1920s and 1930s, but still with little economic expression (ZANELATTO, 1998). According to Zanelatto (1998), because the written records on this period are limited, the information collected on the introduction of this segment in the city was obtained through oral interviews, which is why some ideas diverge, including as to the dates of origin of the first ones. potteries and their pioneering spirit. It is known that in the midst of the narratives, the possible names of the first families that were involved with the pottery activity in the municipality emerged, including Bertan, Bortolon, Coral, Cechinel, Frasson, Guglielmi, Guollo, Maccari, Maragno, Matiola, Pellegrin,

Polla, Rochi, Salvan, Sartor, Zaccaron, (CUNHA, 2003, p.70).

### **3. Results and Discussions**

The narratives show that as potteries developed, families that owned land and raw material on their land were abandoning crops and started to dedicate themselves to the production of red ceramics, as this activity provided them with visibility profit. With the high demand for bricks, dozens of potteries started to explore one of the most abundant resources that they had in the place, the clay. The use was such that it ended up depleting this raw material, requiring these producers to look for new sources in other nearby locations.

The removal of clay in an unplanned way, causes serious impacts and damages to the environment (KOPEZINSKI, 2000). The environmental impact can be positive when man's action on the environment improves the quality of a factor or parameter, or negative, when the quality worsens (ZILLI, 2019). In the production process observed in the brickworks, the impact is hardly positive (PORTELA; GOMES, 2005).

With the civil construction sector booming, Morro da Fumaça gained status as a municipality in 1962, influenced by the economic momentum experienced by the ceramic segment (ZANELATTO, 2011). This sector highlighted the potential of the municipality in relation to neighboring cities, favoring the abundant raw material and the migrant labor, numerous and cheap (CANCELLIER, 2007). At this stage, potteries expand their production, offering services to workers from more distant places, including, it is during this period that sales expand to other Brazilian states and it is precisely during this period that the growth of ceramics in Morro da Fumaça coincides with the extraordinary economic growth that occurred in Brazil in the 70s (ZANELATTO, 2011)".

In this context, several factors contributed to the expansion of potteries in the late 1960s, such as, for example, the expansion of the distribution of electric energy with the creation of the cooperative (CERMOFUL), the drainage of large areas of varzeas of the Urussanga River in 1967, allowing the exploration of matter (clay), the arrival of specific machinery (called marombas) for the installation of pottery, from the states of Rio Grande do Sul and São Paulo, the creation of the National Housing Bank (BNH) which gave great boost in civil construction and, finally, the completion of the Federal Highway BR-101, facilitating the flow of production (ZANELATTO, 2011).

To supply this new demand, it was necessary to hire workers from other locations. Several of these individuals were attracted by the possibilities presented by the pottery owners. Among the "advantages", subsistence items were offered, such as water, electricity and housing, guarantees that generated direct links with the employer. These workers did not arrive alone, they brought their families with them, and in a short time, the population of the municipality practically doubled.

The potteries absorbed all members of the family nucleus that had productive capacity. This condition generally covered everyone in the household, including women and children. The main conditioning mechanism imposed by the owner was that of housing. The worker, even if he was unhappy, saw himself coerced to remain in the job, since most of the time, his residence belonged to the businessman and was linked to the employment contract. Housing, among other elements such as water, energy, and gas, are subsidies that guarantee the domination and permanence of the employee and his family in the pottery.

The housing offered to workers was of very poor quality, belonging to the pottery industry, which deducted from the wages paid by the rents for renting them. The amount of the rent was already deducted from the payment amount, which became a purely economic reasoning, since its calculation always favored the company. A common characteristic at this juncture was that many of the owners of the ceramics were also the owners of the local markets, which is why they settled their wage obligations with a purchase voucher. Receiving with vouchers further limited the real possibilities of development and autonomy for these families.

The natural conditions of the region and the abundant cheap labor, made possible the development of the ceramic sector of the city, which provided its national recognition. The history of the municipality has a very close relationship with this segment, as it was responsible for the economic growth of the place, and possibly even the name of the city was given in its reference.

It is not just today that women have been fighting for space in the job market, however, they “come up against” a series of situations that hinder their trajectory. These confrontations occur partly because it is a phenomenon that refers to gender relations. When we talk about gender relations, what are we talking about?

The term Gender was a concept constructed socially seeking to understand the relations established between men and women, the roles that each one assumes in society and the power relations established between them (COSTA, 2013). Therefore, talking about women, in terms of aspiration and project, rebellion and constant search for transformation, talking about everything that involves the female condition, is not just a desire to see this woman rehabilitated in the economic, social and cultural planes.

It's more than that. It is assuming the uncomfortable posture of being indignant at the historical phenomenon in which half of humanity has been excluded for thousands of years in different societies, over time. It is to believe that this condition, perpetuated in a universal dimension, must be radically transformed (TELES, 19990).

When it comes to equal rights, women are still disadvantaged, especially when it comes to the labor market. In many cases, she still needs to be doubly prepared and qualified for a role she wants, especially if it is also valued by competitors of the opposite sex. Even though the participation of women in the labor market increased, there was no decrease in professional inequalities between the sexes (ABRAMO, 2000).

“The burner has no weekend, holidays or holy days. If you have production, you have to work ”(SHUSTER, 1997)). When reading this outburst, one can assume that it is the story of a ceramic worker, whose life is summarized in the burning hours of a pottery oven. This really represents, the only difference, is that this information was given by a woman, who in order to maintain the family support, occupied the work functions that were of her deceased husband.

This is not a reality exclusive to this woman, nor is it restricted to this sector of the economy. The income of this and many families depends in part, or in its entirety, on women's work. According to information taken from the Senso carried out by the Federation of Industries of the State of Santa Catarina in 2010 about the number of workers in the State of Santa Catarina, there is an approximate calculation of 796,320 women in the most diverse areas of the economy.

Despite being a significant presence in the pottery space of Morro da Fumaça, women, little, or do not appear in the published historiography on the subject. Academic production regarding the daily lives of working women is a recent study. According to Matos, this was due to the “effervescence of women's

struggles and the initiative to place female experiences and experiences previously silenced in history” (MATOS, 2009). Provoking this type of debate in academic circles contributes to transforming mentalities reinforced by social hierarchies that assign roles to men and women within a society.

Only more recently, from 1975, with the establishment of the International Year of Women, did Brazilians resume the feminist movement, working in study groups and scheduling days of struggles and mobilization campaigns. Integrated with democratic movements, Brazilian feminists have joined ranks in movements for amnesty, political freedoms and a free and sovereign constituent (TELES, 1999).

Despite these advances, women still face daily challenges, struggle for their space, recognition, visibility, respect and autonomy in relation to men. With regard to Morro da Fumaça, more specifically to the ceramic space, in order to be able to contemplate and give visibility to the role that the female workforce represented within it, it seems important to historicize and to know how this sector of the economy is developed in the municipality.

The act of migrating occurred in practically all periods of history and for the most varied reasons and circumstances. Among the most common factors are those of economic origin, which include the migrations that occurred in the municipality of Morro da Fumaça. What characterizes this migration as an economic one is the reciprocal need for generation and income, both for the owner and for the future pottery worker.

Most of the workers who went to Morro da Fumaça in order to work in the pottery, agreed with the owner the job and the place to live and, in some cases, even the family belongings were brought by the new boss (ZANELATTO, 2011). Villar (1988) describes it as a “family pater” system, as it leases the families of workers on the company's own land and offers housing, electricity and additional remuneration for an individual capable of providing services. This type of situation generates dependence from the family group on its employer, a situation similar to others already witnessed in history.

As mentioned, the migrations took place in a familiar way, and all members of this group needed to work in the potteries. This was a real necessity, as living conditions were precarious and wages were very low. Taking into account the composition of the workers, it can be understood that they comprised a heterogeneous group that included men, women and children, and that the organizational form of production was structured according to the potential and physical capacity of each one.

Women performed any functions that were employed, however, they were generally assigned those that required skill and concentration. This did not mean that the tasks performed by these workers were simple or less important than those developed by men. In reality, many of them performed functions that required much more than their own physical strength. As is the case of the worker, Eva de Sá, who when becoming a widow needed to assume the obligations of her husband in a pottery oven as a burner, to do considered the hardest within this type of company, as it requires resistance and time availability from those who runs it.

The pottery worker is a woman whose life is determined by work. She lives at work and has the ability to privatize the production space, which is also the space where she takes care of, looks at her children, socializing them for life and qualifying them for work. The possibility to take the children to work and to superimpose their roles and their working hours is not a privilege for the worker. On the contrary, it is an arrangement suited to the interests of the owners of the brickworks who maintain a “qualified” workforce

for the job held in place for more than three generations (D, AQUINO, 1989/90, p.118).

The hours and obligations at the pottery were precisely followed, obeying the organization of production. Such organization was given by the system of sexual division, which directly reflected in the form of payment of each employee. The process took place through the "win according to what you can carry" system, that is, within this logic, you paid better to those who produced more, this generally favored men who had greater hand strength (SHUSTER, 1997). This strategy made female labor very cheap, since these workers did not have the same physical power as men, a determining factor in the monetary value they would receive.

The female labor force was quite advantageous to the company, because, the productive capacity of women was practically equal to that of men and the wages disbursed were lower than the same. Even though the worker performed activities that were the same or similar to those of men, the occupation performed by them was still rated as "help" or supplement. This is a characteristic of the sexual division of labor, which in turn manifests itself unevenly, as it separates the work of men and women into degrees of superiority and inferiority, leading to the understanding that the work of a man is worth more than that of other.

Because it is considered a work of less importance, more "light", which requires "little" physical effort, female labor is marginalized within the productive space of ceramics. However, as we can see below, women perform the most diverse types of tasks within this process, including those that are called masculine.

"- I'm a furnace now. I work in the oven."

- It's filling up a brick cariola to take to the oven, load a truck ...

"Q. - Why do you do that?

"- Because there is no bank."

Q. - And how is this job for the woman?

"-Ah! It's bad."

"- It is her husband who wins, she earns nothing ... Her service is awkward (encompassed) with her husband."

"- For me it doesn't pay anything. Just for him. It pays three hundred thousand ..."

Q. - And isn't it heavy to fill a cariola?

"- And, but what am I going to do?"

Q. Is it heavier than the cut?

"- Vichi ... Wow ... This service is for men, not for women."

"- I was a kneader too, now that I'm in the oven."

Q. - Did you knead clay?

"- Yeah, I kneaded. Like her there. Help her husband with the kite."

Q. - And help with the kite and the oven, which is the heaviest?

"- Ah! I find the oven." "- All of them are heavy because filling a cart there with that heavy shovel, my daughter, is not easy, no."

"- All two are heavy." "- Lower and raise ..." (D, AQUINO, 1989/90, p. 123).

Even carrying out various activities that required great physical development, the oppression that



women experienced is still undeniable. This unequal relationship subordinated the worker and subjected her to the domination of the boss, the supervisor and even the husband, and this only accentuated the question of power concentrated in male hands.

The need to earn income, required many women to enter the labor market early. In the logic of pottery, this occupation was laden with responsibilities, in many cases study and leisure, were in the background. The moment the worker became a mother, a new cycle began. Children now represented new concerns. Children give women and men a majority status, making them responsible for their own destiny, which ideally implies disconnecting from the family of origin and constituting a new family nucleus (SARTI, 1996).

The education given by these mothers and workers was about practical knowledge. The teaching was focused on observation, and the exchange of experiences. This type of learning, almost empirical, in these circumstances became more valid than what was offered by the school. This may be a reason that justifies the removal of these children from school education. Everything suggests that this was a common life practice for pottery families.

Even though they became parents and responsible for the organization of their home, their obligation to work in the pottery with their husband was not extinguished. In fact, this became even more necessary, as it is at this time when financial fragility was accentuated. This aspect highlights and highlights the overload of responsibilities carried by women in relation to men. We cannot forget that “the lack of a day care center was and still is an issue that is always present in the meetings of women from the periphery and some union members. And one of the priority flags, the creation of a nursery ”(TELES, 1999). They were assigned a double working day, where the responsibility for domestic activities and for the care of children was mixed with their economic activities developed within the factory space.

When working hours are added, the total time spent working inside and outside the home is always greater for women (BANDEIRA; PRETURLAN, 2013). In addition, these women were responsible for external activities, actions responsible for maintaining the house, such as trips to the supermarket, payment of bills, among other obligations. They had to face the difficulties of managing the low salary received by their family, dividing it between expenses, leisure and obligations.

## **4. Conclusion**

The brickworks appeared in Morro da Fumaça at the beginning of the twentieth century, and promote an unprecedented wave of economic development to the newly created municipality. The dynamics of progress are fraught with social inequalities, since those who actually generate wealth are not benefited by it. In this context, a mass of male and female workers emerges who are in charge of occupations that cause damage to health, with low wages, unfair employment ties, which provide few prospects for life. It is in this scenario of precariousness and exploitation that women are inserted in the potteries of the municipality of Morro da Fumaça.

This research explained how work relationships were maintained, especially the daily lives of workers in ceramic pottery, showing power and resistance relations inside and outside this space. We tried to treat these women as generators of their own stories and, in order for this to be possible, it was necessary to

diverge from the historiography already produced that favored positivist approaches.

From this research it can be said that the workers were present from the first ceramic installations in the municipality of Morro da Fumaça, operating the most diverse functions within this segment. We identified the unavoidable need for the female presence within the brick factories and the arbitrary form that they went through regarding their remuneration lower than that of men. It appears that history has tried to offer women the role of supporting, resigned and oppressed, for this reason, it is necessary to outline new proposals on how to write narratives, which does not segregate or subjugate any worker.

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# **Innovation Policy and the Role of Accounting in the Strategic Management of Technology Transfer: A Study in the Scientific, Technological and Innovation Institutions of Northeast Brazil**

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## **Abstract**

*This research aims to analyze whether Intellectual Property assets of Federal Institutes (FIs) in Northeast Brazil are being measured, accounted for and evidenced in Financial Statements (FSs) of these Scientific, Technological and Innovation Institutions (STIIs). Therefore, in order to achieve the proposed objective, a bibliographic, exploratory, and descriptive research was carried out. This survey was achieved through a qualitative approach from document analysis and collection of secondary data related to innovation policies of FIs, and valuation and accounting of IP assets. The results showed that patent registrations granted and Technology Transfer (TT) are still incipient, although the majority of the Technological Innovation Nuclei (NITs) of Northeast FIs have innovation policies that support intellectual protection of*

*inventions. Even though there are Brazilian Accounting Standards (NBCs) that uphold the process of measuring, recording and disclosing of IP assets, such as NBC TG 04 (R4, 2017a) and NBC TSP 08 (CFC, 2017b), this result can also be due to an absence of structured and guiding procedures within the scope of NITs' innovation policies.*

**Keywords:** Asset accounting; Innovation Policy; Intellectual Property; Asset valuation.

## 1. Introduction

In a contemporary world, whose nations have continuously sought economic and social development in order to meet society demands, it is observed that global governments have resorted to public policies that favor investments as strategic elements for development of science, technology and innovation. Thus, it seeks to induce economic behavior that contributes to leverage national competitiveness and favor foreign capital attraction (Amorim, 2019).

Therefore, from Brazilian Law No.10,973/2004 creation, entitled the Law of Innovation, induction of scientific and technological development was instituted, which seeks to favor innovation generation in productive environment and guide Technology Transfer (TT) processes (Brazil, 2004).

The proposal to induce an innovation ecosystem brought by the Innovation Law also instituted Technological Innovation Centers (NITs), which have the role of managing innovation policy and intermediating TT processes within the scope of Scientific, Technological and Innovation Institutions (STIIs). Thus, NITs are responsible for managing innovation policy and negotiating TT agreements associated with Intellectual Property (IP) assets of these STIIs.

In the midst of creating an innovation environment in Brazil, a new legal framework for science, technology and innovation was instituted in 2016: Law No.13,243/16. It amended Law No.10,973/2004, in addition to bringing innovations in aforementioned processes, it also favored capture and generation of resources for Brazilian STIIs (Brazil, 2016). Thus, with the national legal framework, it is expected that TT processes of IP assets generated by STIIs can happen in a more systematic way, favoring approximation and relationship strengthening among these institutions and the productive sector.

IP assets can be defined as any production of human intellect, whether in industrial, scientific, literary or artistic domain. Due to the effort in the development of these creations, the author has the right to protection, which is protected by law and aims to encourage the continuation of these activities and provide economic return (Santos, 2019).

Thus, it should be noted that both legal aspects and economic-financial aspects of IP assets are directly related to public accounting, to which public STIIs are subjected, due to what accounting legislation imposes regarding the need to measure these assets (monetary valuation), registration in internal controls of these institutions and their evidence through Accounting statements (ASs), according to NBC TSP 08 (CFC, 2017; Brazil, 2007). Furthermore, it is also noteworthy that relationship among public accounting, and scientific and technological development of STIIs is due to the need to control public resources flow involved in these inventions and their transparency to society.

The disclosure of IP assets by public STIIs is an important process for the fulfillment of

accountability to society. Thus, among other innovations, Brazilian Law No. 11,638 created the obligation for organizations to recognize intangible assets in their ASs in 2007, whose item VI, of Art.179, established that IP assets must be classified within the group of non-current assets in an intangible account. In addition, in Article 183, item VII, the Law defines that evaluation criteria for rights classified as intangible should be measured based on the cost incurred, reducing the respective amortization account (Brazil, 2007). In addition, the recognition of intangible assets must comply with the Brazilian Accounting Standards applied to the public sector, according to CFC (2017).

On the other hand, although accounting legislation brings the need for control and management, and the legal bases for recognition and registration of IP assets, in public STIIs scope, absence and/or incipience of measurement, registration and disclosure has influenced both, negotiation and transfer of these assets to the productive sector, regarding marketing aspects, and attraction of interested entities. Consequently, this fact impacts disclosure in ASs, which leads to non-compliance with Brazilian Accounting Standards applied to the Public Sector (NBC TSP) (Ferreira, 2019; Guimarães, Kniess, Maccari, & Quonoan, 2014; Teodoro, 2015).

According to the research by Araújo and Leitão (2019), which aimed to investigate the adoption of NBC TSP 08 by Federal Higher Education Institutions (HEIs), following the example of Universities, analyzing accountants' perception of twenty-four (24) HEIs, the authors noted that STIIs have encountered difficulties in applying NBC, which impacts the disclosure of these intangible assets to society. That is, despite the existence of accounting procedures and criteria for a measurement, recording and disclosure of intangible assets, such as IP assets, defined in particular by NBC TSP 08 (focus on the public sector), some public STIIs have not carried out such procedures, failing to evidence in their ASs and consequently underestimating their assets.

At the Institute of Technological Research of the State of São Paulo (IPT), for example, despite having knowledge of technology valuation methods, according to Guimarães, Kniess, Maccari and Quonoan (2014), there are cases of patents that were not valued (accountably measured), due to problems related to expenditures survey involving technology conception and royalties post-sale for IP commercial exploitation.

This reality has also been common in Brazilian Federal Institutes (FIs), especially in the FIs of the Northeast Region, the object of study in this research (MCTIC, 2017). Created by the Law No. 11,892 in 2008, these FIs are part of the National Innovation System (SNI) (Souza, 2020), which among other objectives, it should contribute to innovation generation, and local, regional and national economic and social development (Brazil, 2008; Souza, 2020). According to Araújo *et al.* (2018), Ferreira (2019) and Souza (2020) these FIs have developed technological production, however processes of valuation (monetary value measurement), negotiation, and TT has not happened systematically.

Given the above and considering that public STIIs need to account for their assets, in particular intangible results of investments in scientific and technological research; considering the importance of an adequate accounting record so that public entities can represent, in a reliable way, their assets and that innovation policies of these federal STIIs must guide IP assets management; whereas measuring IP assets' monetary value is an essential process for trading and transferring them to the productive sector (Ferreira, 2019); and that despite FIs develop IP assets, particularly those in the Northeast region, they have



encountered difficulties in their valuation and accounting (Ferreira, 2019; Teodoro, 2015; Guimarães *et al.*, 2014), we sought to answer the following question in this research: **Are the Intellectual Property assets of Federal Institutes (FIs) in Northeast Brazil being measured, accounted for and evidenced in the Financial Statements (FSs) of these Scientific, Technological and Innovation Institutions (STIIs)?**

Therefore, the general objective of this research was to analyze whether the Intellectual Property assets of the Federal Institutes (FIs) of Northeast Brazil are being measured, accounted for and evidenced in the Financial Statements (FSs) of these Scientific, Technological and Innovation Institutions (STIIs). As a secondary objective, the research also investigated the strategic role that accounting can play, as a tool to support assets' negotiation and in management of resources linked to STIIs innovation policy in TT process. To this end, an exploratory, descriptive, bibliography, documentary and qualitative research was carried out, through an analysis of scientific, legal and institutional documents of Northeast FIs.

Northeast FIs were chosen as units of analysis for two reasons: firstly due to its low index of TT records (MCTIC, 2017). Furthermore, until the end of the present study, they had a low percentage of patent production when compared with STIIs in other regions of the country (Araújo *et al.*, 2018). In addition, this study is part of the research project financed by CNPq, according to the Universal Notice MCTIC/CNPq 2018, entitled "*IP and TT within the scope of Northeast Region FIs: A study on the patent evaluation and valuation procedures adopted by NITs in TT processes*".

It is also noteworthy that researches carried out so far has failed to investigate the objective proposed in this research, such as the following: The research by Araújo *et al.* (2018) that carried out IPs evolution analysis (patents, brands and software) deposited/registered at the National Institute of Industrial Property (INPI) by Northeast FIs from 2006 to 2016. Souza (2020) investigated how IFBA's IP and innovation policy contributes to development of technological production and TT. In turn, Ferreira (2019) monetarily valued the first patent granted to IFBA, entitled fish smoker through an alternative valuation method. While Guimarães *et al.* (2014) investigated patents valuation under the IPT NIT.

Thus, this research may contribute to accounting professionals practice at IP assets management within Northeast FIs scope, as well as a support to decision making by STIIs managers in the process of managing innovation policies, negotiation and TT of these assets to the market, as well as in resources control that are invested in innovation.

## 2. Literature review

### 2.1 Innovation policies

In the eighteenth and nineteenth century, the State played a role that was aimed at public security and external defense in an event of an enemy attack. With democracy expansion, the responsibility of the State is now directed towards promoting social welfare. In order to achieve it, public policies are used to represent a set of actions, goals and plans that a government determines to achieve society well-being and public interest (Lopes; Amaral; Caldas, 2008).

In Brazil, according to Távora, Dias, Melo and Kelner (2015), public policies promulgated by the government aim to make the country more competitive, through sustainable and equitable development. Some of these measures resulted in FIs emergence, which, through Law No.11,892 of 12/29/08, brought a

new model of professional and technological education, as well as the creation of FIs innovation policies, which, through what is provided by Law No. 10,973/04 and its modifications, should contribute to scientific and technological production, and thereby increase national economic development, driven by innovation (Brazil, 2004; 2008).

According to Emmendoerfer (2019), innovation in the public sector is an idea (new, improved or renewed) and systematized for the scope of its application, aiming to solve a problem of public interest. From problems diagnosis, alternative solutions are analyzed to find out which one is the most appropriate. For him, innovation in the public sector comes from improvements search.

A very broad concept covering innovation is found in the Oslo Manual (2018), as it refers to a new or a significantly improved implementation of a product or process, or marketing method or organizational method in business practices, as well as within an organization workplace, and external relations (OECD, 2018).

One of institutions' growth strategies is through innovation, as it drives economic progress and competitiveness. According to the Schumpeterian Competition Theory, the capitalist economy is dynamic and over time has undergone an evolution through economic changes and innovations. There is a constant search for agents differentiation through strategies or differentiation in product and quality to obtain competitive advantage (Kupfer & Hasenclever, 2013). According to Schumpeter (1984), what drives capitalism and keeps companies on the market is the entry of new consumer goods, new methods of production or transport, markets, as well as new forms of industrial organization.

Given this perspective, it is necessary that institutions constantly remodel scientific and technological processes through innovation. Therefore, Law No.10,973/04 came to encourage strategic alliances formation among universities, technological institutes and companies/productive sector, in addition to encourage these institutions to act on innovative entrepreneurship (Brazil, 2004). Subsequently, the Law No. 13,243/2016, of a new legal framework for innovation emerged, aiming to accelerate TT process (Brazil, 2016).

The Law No.13,243/2016 is oriented to economic development and reinforced implementation of an innovation policy in the entrepreneurial STII model, for which it is necessary to intensify efforts directed to strategies and actions in: (i) training of strategic human resources ; (ii) entrepreneurship in the technological area; (iii) public-private partnerships; and (iv) international cooperation (Brazil, 2016). Thus, it is worth mentioning that people training with deep knowledge and intellectual capital developed in different areas is possible to obtain a favorable result in innovation.

In Nazareno's perception (2016), the new legal framework rewrote most of the innovation law to meet the three constitutional axes, namely: integration, simplification and decentralization. This means private companies participation integrated into public research system; administrative, personnel and financial processes in a simple way in STIIs; and participation of States and Municipalities in supporting innovation by granting scholarships and incentives. The objective of these measures is to accelerate achievement and result of projects and research, in order to generate an increase in STII revenues.

According to Amorim's research (2019), which aimed to analyze whether Northeast FIs innovation policies are aligned with the new legal framework, it was concluded that their patent valuation and negotiation guidelines are distant from the national policy of innovation, these being some possible factors

that hinder effective use and transformation of knowledge into innovation. In addition, according to the author (2019), Northeast FIs innovation policies are distant from the national innovation policy, since the following issues are still incipient: a) stimulating independent inventor; b) investment funds; c) patent valuation and negotiation guidelines; d) STIIs internationalization; e) innovation-related budget; f) accountability; g) contracting of products; and h) goods import for research, development and innovation, among others.

The Innovation Law established that STIIs should create structures and spaces called NITs in order to manage innovation policy, IP and TT (Brazil, 2004). Thus, a NIT is the sector responsible for innovation policy managing, stimulating and monitoring IP-directed activities and actions related to technological innovation (IFBA, 2017). Therefore, its performance is closely linked to accounting as, among other activities, it requires measurement, recording and disclosure of IP assets monetary value and, consequently, has its own methodologies for this purpose.

## ***2.2 Accounting as a strategic tool in the registration and control of intellectual property assets and innovation-related investments in STIIs***

According to the research developed by Júnior and Almeida (2019), whose objective was to analyze patents of northeast federal public universities in relation to the market, it was observed that interaction among the productive sector and STIIs is incipient, because inventions generated in the latter are not in line with market demands. Thus, TT is not carried out, generating costs for public coffers.

The research carried out by Cabrera and Arellano (2019) that aimed to identify the main problems faced by university managers in relation to technologies valuation, resulted in: lack of accurate information about the market, production costs, and marketing and specific references on royalty rates, and knowledge lack on valuation methods [emphasis added], as well as low level of technology development, in addition to interest lack of some companies in investing in Research and Development (R&D) because they understand that these activities are not aligned with their business portfolio.

According to the research developed by Araújo and Leitão (2019), highlighted earlier, the authors concluded that these assets disclosure is compromised since there are difficulties in applying the standard. However, most professionals recognize the importance of this information and believe that it can assist in the decision-making process. According to the research carried out by Ferraz (2009), which aimed to analyze an accounting method for IP assets in forty companies in Brazil, it was observed that an effective way to attract investments is to correctly register IP assets values and demonstrate to the real company's situation. It is worth remembering that accounting science is the fundamental tool for valuing, registering and evidencing intangible assets, providing more transparency and facilitating negotiation and TT process.

In some public institutions, lack of valuation and disclosure of IP assets can impact on TT processes, because it creates a commercial barrier and makes it difficult to verify economic, financial and equity advantages return for entities, such as FIs (Ferreira, 2019). It is observed that activities of valuing technologies and patents are still incipient in Brazilian STIIs (Guimarães *et al.*, 2014). This is due to a difficulty of measuring an IP value, which makes it difficult to recognize an intangible asset, as well as its accounting and disclosure by STIIs (Adriano & Antunes, 2016).

Thus, it is worth highlighting the role of Accounting, an applied social science, which aims to

provide information on equity and alterations of an entity to users in general (Iudicibus, 2010). Therefore, it has an informative role concerning phenomena and equity variations.

Given its nature and method, Accounting has a strategic role in valuing inventions created by STIIs that can drive national economic progress, through TT towards innovation. Since accounting procedures assist in valuation, negotiation and TT, it becomes possible to bring innovation to the market and obtain a competitive advantage for organizations. Thus, in order to support process of valuation and negotiation of public STIIs through measurement, registration and disclosure, in addition to financial reports, it is essential that these entities incorporate accounting criteria and procedures, guided by Brazilian NBCs in their innovation policies.

Among the accounting tripod (measuring/valuing, from a monetary point of view, recording and evidencing relevant information about an entities' equity changes for decision-making process), valuation stands out, since it consists of monetary value measuring of an asset in order to subsidize both registration/control of the asset and its disclosure in an entities' FSs, in addition to supporting TT process negotiation with potential buyers/licensees. There are several aspects involved in this valuation calculating process, among which the following stand out: (i) technology nature; (ii) development degree; (iii) intellectual protection strength; (iv) potential to generate competitive advantage; (v) market characteristics; (vi) involvement degree of inventors; and (vii) commercialization or entrepreneurship capacity (Cabrera & Arellano, 2019). Furthermore, according to Ferreira (2020), it is important to observe the invention Technological Readiness Level (Ferreira & Souza, 2019; Ferreira *et al.*, 2020).

Measurement is a cost assessment that involves complex interactions of economic resources, which hinders its realization. In turn, recognition is when a resource/record appears in an entity's FS. It turns out that when it involves an intangible asset, there is a greater challenge to recognize it, as it cannot be registered when it is not possible to measure previously (Hendriksen & Van Breda, 1999).

According to NBC TSP 08 (CFC, 2017b), which provides for the accounting treatment of intangible assets, an entity should only recognize these assets if the criteria specified in the standard are met, which are: (i) intangible asset definition (identifiable non-monetary asset without a physical form); (ii) when future economic benefits or service potential are probable and asset cost of can be measured with confidence. In this standard, it is also evident how book values measurement of intangible assets should be, and requires specific disclosures about these assets (CFC, 2017b).

Thus, initially, an intangible asset must be measured by costs sum from the date in which met the recognition criteria. Following, the institution must define between the cost or revaluation model. Concerning the first model, recognition is made from total cost, that is, a sum of expenses incurred as of the date that meets the recognition criteria, which should reduce amortization, as well as other accumulated losses. The second model is defined as a fair value on the revaluation date minus any amortization and accumulated losses. This value is based on an active market, and revaluations should be made regularly to avoid distortions in the book value (CFC, 2017b).

According to Teodoro (2015), intangible assets like patents (IP assets), as they do not have an active market, transactions are carried out in confidentiality and, therefore, previous values are not used as a reference. According to the Accounting Manual Applied to the Public Sector (MCASP) (MF, 2019) and NBC TSP 08 (CFC, 2017b), with regard to initial recognition of an intangible asset generated internally, in

addition to meeting general requirements for recognition and initial measurement, as already informed, it is necessary to identify the research phase and the project development phase.

Regarding the first phase, as it is not able to demonstrate an intangible asset existence in generating future economic benefit, this recognition should be a diminishing equity variation and, therefore, recognized as an expense. In the development phase, if an entity demonstrates all aspects contained in item 6.3.2.2. MCASP and item 55 of NBC TSP 08 (CFC, 2017b), the asset should be recognized as intangible. The aspects of item 6.3.2.2, according to CFC (2017b, pp. 12) and MF (2019, pp. 194) consider:

- a. Technical feasibility for intangible asset conclusion so that it is available for use or sale;
- b. Intent to complete the intangible asset in order to use or sell it;
- c. Ability to use or sell the intangible asset;
- d. How the intangible asset should generate future economic benefits. Among other aspects, the entity shall demonstrate the existence of a market for intangible asset products or for intangible asset itself or, if it is intended for internal use, its usefulness;
- e. Availability of technical, financial and other adequate resources to complete its development, in order to use or sell the intangible asset; and
- f. Ability to reliably measure the expenses attributable to the intangible asset during its development (Ministério da Fazenda, 2019, pp. 194); (CFC, 2017b, pp. 12).

NBC 04 (R4, 2017a) and NBC TSP 08 (CFC, 2017b) signal that if there is an active market for intangibles, it should be used. However, there is no such market for brands and patents in Brazil, because this is a particular asset. Negotiations are carried out among parties and there is no prices history for comparison, which makes it difficult to define an asset value and TT.

It should be noted that an intangible asset cost generated internally, which is used for accounting recognition, involves all necessary expenses for creation, production and preparation of the asset to be able to start operating, such as: material and services costs, employee benefits, registration fees, and amortization of patents and licenses that are related to this asset generation (Ministério da Fazenda, 2019; CFC, 2017b).

In addition, it is necessary to evaluate this asset useful life for amortization purpose. If defined, it must be carried out over the course of its life; otherwise, there will be no amortization, as there is no predictable limit for the period during which the asset would generate positive cash flows. In this case, an impairment test must be carried out. This test is performed annually on intangible assets, which have an indefinite useful life in terms of impairment by comparing their carrying amount (CFC, 2017b).

Thus, it is observed that accounting is a strategic tool for innovation policy management of public STIIs, as it allows not only to manage and control financial flows allocated by STIIs in scientific and technological development, but also to measure IP assets monetary value, especially those generated internally. In addition, it helps in an invention negotiation process, through a fair value and contributes to TT in the market, supporting decision-making process of partnerships, through licensing, besides giving transparency to resources invested by STIIs in scientific and technological research (Araújo & Leitão, 2019; Ferreira, 2019; Teodoro, 2015).



### 3. Methodology

#### 3.1 Research characterization

This research is characterized as an exploratory one, as it aims to know each Northeast FI, study object of the present investigation, as well as to explore their particularities and compare them. According to Gil (2008), the exploratory aspect is a study type that aims to provide the researcher with greater knowledge on a subject, thus being able to improve ideas or create hypotheses to be studied later.

In addition, it is also characterized as a research of survey, descriptive, and with a qualitative approach, which aims to qualify data collected from bibliographic and documentary research.

According to Severino (2007), a survey is a data collection that is more suitable for descriptive studies, without the researcher's intervention and handling. The typology is descriptive, as it addresses description of innovation policies and intangible assets recognition or not of Northeast FIs. According to Gil (2008), this research type describes the characteristics of a specific population or phenomenon, as well as it can establish associations among variables determining a relationship nature.

As for the approach, it is a qualitative research, whose purpose is to describe Northeast FIs innovation policies, as well as, to investigate if there is disclosure of intangible assets in FIs, though with no concern with statistical analyzes. According to Prodanov and Freitas (2013), the qualitative approach is a process based on the interpretation of phenomena and the attribution of meanings, not using statistical methods and techniques.

On the other hand, the research nature is bibliographic and documentary, since the first one results from records analysis in documents (books, articles, theses, dissertations) from previous researches (Severino, 2007). In relation to documentary research source, innovation policies, management reports and Balance Sheet (BS) of Northeast FIs were used. In Gil's (2002, pp. 45) point of view: "a documentary research uses materials that do not yet receive an analytical treatment, or that can still be reworked according to research objects".

#### 3.2 Analysis Unit

The research sample was concentrated in Northeast FIs, which total 11 (eleven) unities, whose campuses are distributed in nine Brazilian states. Bahia and Pernambuco are the only states that has two institutes each one, which are: IFBA and IFBaiano (Bahia), and IFPE and IF-SERTÃO-PE (Pernambuco) (Brazil, 2008). As already highlighted in the introduction, this scope is justified due to a low index of TT records of these institutions (MCTIC, 2017), as well as a low percentage of patent production, according to Araújo *et al.* (2018). Thus, the research sample was constituted by the following institutions: IFAL - Federal Institute of Education, Science and Technology of Alagoas; IFBA - Federal Institute of Education, Science and Technology of Bahia; IFBAIANO - Federal Institute of Education, Science and Technology Baiano; IFCE - Federal Institute of Education, Science and Technology of Ceará; IFMA - Federal Institute of Education, Science and Technology of Maranhão; IFPB - Federal Institute of Education, Science and Technology of Paraíba; IFPE - Federal Institute of Education, Science and Technology of Pernambuco; IFPI - Federal Institute of Education, Science and Technology of Piauí; IFRN - Federal Institute of Education, Science and Technology of Rio Grande do Norte; IFS - Federal Institute of Education, Science

and Technology of Sergipe; IFSERTÃO - Federal Institute of Education, Science and Technology of Pernambuco's Sertão.

According to the Information Form on STIIs IP Policy and Innovation in Brazil (FORMICT, 2017), which aimed to present consolidated data provided by STIIs to the Ministry of Science, Technology, Innovations and Communications (MCTIC), it was found that the Northeast region has a low index of technology contracts, totaling only four (4) contracts, one justifying reason why this analysis unit was chosen in this research.

### ***3.3 Steps and procedures***

In order to achieve the proposed objective, the present research was developed in three stages: the first one refers to a bibliographic survey carried out from books, articles, theses and dissertations, and a documentary research related to innovation policies and IP, FIs' management reports, as well as documents related to measurement, accounting and disclosure of IP assets in ASs/FSs. Furthermore, secondary data regarding Innovation Policies and Management Reports were obtained through a search on institutional websites.

The ASs/FSs were obtained through the Union General Comptroller (CGU) e-SIC (Electronic System of the Citizen Information Service) request sent to the STIIs, through an exploratory research. The 2018 request for ASs/FSs aimed to understand how FIs classifies IP assets in their ASs/FSs and to contribute to disclosure improvement of these assets in these institutions' statements. The 2018 length of time was chosen due to the e-SIC protocol opening period, when STIIs had not made 2019 ASs/FSs publications. Requests were sent to the eleven (11) Northeast FIs.

In the second stage, a data treatment and analysis from the information extracted from innovation policies, management reports and FSs was carried out. Finally, in the third stage, data analysis was carried out, as well as the final considerations.

Furthermore, it is noteworthy that this research was limited to investigating whether IP assets generated by Northeast FIs are being measured, accounted for and evidenced in STIIs' FSs, as well as the strategic role that accounting can play in their innovation policies, although it should not be generalized to other FIs.

## **4 Analysis and Discussion of Results**

### ***4.1 Innovation policies of Northeast FIs***

A well-defined innovation policy in FIs helps to meet structural needs of technological education and innovation, in addition to being one of the factors that contribute to improvement of the country's macro, microeconomic and social indicators. Thus, it is necessary to define strategies for a correct implementation of these policies according to the country's economic and social interest relevance, and technological development. However, it is observed that not all Northeast FIs have current innovation policies, and thereby there are obstacles to purposes' fulfillment for which they were created (Amorim, 2019), in addition to not meeting the Law on Innovation and to the New Legal Framework.

When analyzing the collected documents, shown in Chart 1, it was observed that the IFs that have a



published innovation policy were IFAL, IFBA, IFCE, IFPB, IFPE, IFRN and IF-SERTÃO-PE. Nevertheless, innovation policies were not identified at other FIs until the end of the research, namely: IFBaiano, IFMA, IFPI and IFS.

Chart 1. Northeast FIs documents

INSTITUTES	DOCUMENTS
IFAL	Superior Council Resolution No.06 of 06/12/17
IFBA	Resolution /CONSEPE No.64 of 10/17/19
IFCE	Resolution No.05 of 02/04/11 and Innovation Policy Draft of 02/15/19
IFPB	Innovation and IP Policy - Resolution <i>ad referendum</i> No.13 CS of 05/22/17
IFPE	IP, Technology Transfer and Innovation Policy– Resolution No.31 of 07/02/15.
IFRN	Policy for Scientific and Technological Development, Innovation and Entrepreneurship – Deliberation No.09 of 06/01/17 – CONSEPEX
IFSERTÃO-PE	Innovation Policy - Superior Council Resolution No.34 de 10/26/17

Source: Prepared by the authors (2020) based on research data.

IFAL has the Superior Council Resolution No.06 of 06/12/17, which provides for IP and innovation rights ownership and management. However, there is no information regarding valuation and TT, as well as aspects related to accounting treatment related to IP assets records (IFAL, 2017).

In the IFBA, on 10/17/19, the Innovation Policy approved by Resolution No.64 of the Teaching, Research and Extension Council (CONSEPE) was published. This Policy is aligned with the objectives and guidelines of article 15-A of Marco Legal Law and Decree No.9,283 of 02/07/18. This document contains elements that deal with innovation management, entrepreneurship, IP and TT. In its text, management activities that refers to technology transfer and licensing are included, but it fails regarding measurement and accounting procedures that are essential for valuation of these assets (Brazil, 2016; 2018); (IFBA, 2019).

It turns out that there was a delay in the issuance of such internal IFBA standards in comparison with legal provisions in force today. According to Souza (2020), the time lag of more than three years between Law No.13.243 of 01/11/16 and the innovation policy publication, may have generated losses in some actions developed, since the law established changes that aim to give more autonomy in formulation and execution of innovation processes, stimulating entrepreneurship and innovation. Furthermore, according to the author (2020), it may have compromised NIT activities since assignments were included that aim to improve the relationship among STII and the private sector (Souza, 2020).

Regarding IFCE, Resolution No.05 of 02/04/11 was verified, which provides for the innovation policy, regulates the NIT and provides other measures. The Innovation Policy Draft of 02/15/19 suggests elements referring to valuation, negotiation and TT of equity rights in its creations. However, it does not list procedures that should be adopted by this institution, delegating to NIT, in its article 58, to decide on methods and criteria for valuing technology, respecting proper regulations. In addition, it fails to address issues related to accounting treatment of intellectual creations of this institution (IFCE, 2019).

In the IFPB scope, the Innovation and IP Policy - The Superior Council Resolution *ad*

*referendum* No.13 of 05/22/17, whose textual model is similar to the IFPE Policy - Resolution/ CONSUP No.31 of 07/02/15, fail to bring in their content information about: valuation, negotiation and accounting treatment guidelines for patent registrations (IFPB, 2017; IFPE, 2015).

In the IFRN, there is the Policy for Scientific and Technological Development, Innovation and Entrepreneurship, approved by Deliberation No.09 of 07/01/17, which discusses IP activities management, monitoring, valuation, negotiation and TT, and advising on innovation. However, procedures for valuation measuring, and accounting recording in the BS are not listed, which may affect a possible negotiation and TT (IFRN, 2017). As indicated by Guimarães *et al.* (2019), patents' valuation is a tool that helps negotiation for licensing and/or TT to the productive sector.

Regarding the IF-SERTÃO-PE, according to Resolution No.34 of 10/26/17, which deals with the policy of technological innovation, IP, TT and entrepreneurship in article 4, item V, it establishes that one of this policy's objectives is to train human resources according to valuation needs. This resolution also contains guidelines related to TT; nonetheless, it is deficient in relation to IP assets' accounting (IF-SERTÃO-PE, 2017).

In other Northeast IFs, no specific regulation and/or resolution on Innovation Policy was found until the end of this research. However, other documents were identified that are related to instruments of IP and technological innovation, as shown in Chart 2.

Chart 2. Northeast FIs documents

INSTITUTES	DOCUMENTS
IF BAIANO	Resolution/CONSUP No.35 de 09/01/16–NIT Regulation and 2018 Management report
IFMA	Resolution No.111 de 04/24/17
IFPI	Superior Council Resolution No.28 de 12/29/15
IFS	Unavailable - under development

Source: Prepared by the authors (2020) based on research data.

Concerning IFBaiano, the institution reported through CGU that the policy was still under construction. However, the NIT Regulation (Resolution/CONSUP No.35 of 1/9/16) dealing with innovation and IP management is in force. It should also be noted that, until now, IFBaiano has not yet transferred technology from its IP assets and, in turn, has not carried out any type of revenue recording from these assets in its accounting (CGU, 2019). When analyzing IFBaiano's 2018 Management Report, it was identified that the institute, despite having intangible assets produced internally, it was still activated due to valuation lack. Thus, these internally generated assets were recognized as a diminishing equity variation (IFBAIANO, 2018).

In IFMA, it was noted that Resolution No.111 of April 24, 2017 deals with structuring and regulation of technological innovation activities, and follows the guidelines contained in Laws No.10,973/04, No.13,243/16 and Decree No.5.563/05 that was in force in the year the resolution was created. However, issues related to negotiation, valuation and accounting of IP assets were not evidenced in this Resolution (IFMA, 2017).

Within IFPI scope, the Superior Council Resolution No.28 of December 29, 2015 that provides for

industrial equity rights was analyzed. It was found that the policy brings elements in line with the provisions of Law No.10,973/04 and Decree No.5,563/05 that were in force at the time, but there are no guidelines regarding to procedures of valuation, patents negotiation and accounting records. Regarding IFS, it was found that its innovation policy is under construction by the Innovation and Entrepreneurship Department (IFPI, 2015); (IFS, 2019).

Thus, it was observed that IFBAIANO, IFMA, IFPI and IFS need to institute their innovation policies, due to the obligation created by the Innovation Law. In addition, it can generate several benefits for the institution, among them: fostering scientific research, supporting institute's interaction with the productive sector in order to facilitate TT, stimulating an innovative culture generation, and awakening to entrepreneurship. According to Souza (2020), it is not enough to publish an innovation policy. Furthermore, it is important to emphasize mechanism relevance that will be used to allow its effective compliance.

It is worth mentioning that in these policies, specific sections must be created containing general guidelines and the flows that must be followed by managers to conduct valuation and negotiation processes. Therefore, they must follow guidelines applied to the public sector, such as NBC TSP 08 (CFC, 2017b).

In relation to other Northeast FIs policies assessed, only those of IFCE, IFRN and IFSERTÃO-PE have adherent devices with regard to innovation management, valuation, asset trading and TT. On the other hand, it is worth mentioning that it is necessary to have appropriate treatment of accounting procedures in these documents, observing legal and normative provisions, such as NBC TSP 08, as well as MCASP, as it can support patents' measurement and valuation, in addition to being an incentive for records disclosure. In Amorim's (2019) point of view, it is important to emphasize the importance of establishing valuation and negotiation guidelines in its innovation policies, as it strengthens relations with the productive sector.

In Souza's view (2020), it is necessary that an innovation policy is in compliance with legal frameworks so that it fulfills the mission of supporting innovation through TT. Nevertheless, according to Amorim (2019), one of the aspects in which the documents are distant from the national innovation policy is in relation to valuation and negotiation guidelines for patents. In view of this scenario, it can be seen that innovation policies of Northeast FIs are not well defined regarding accounting procedures in order to assist in measurement and TT to the productive sector.

#### ***4.2 Measurement, accounting and disclosure of IP assets by FIs of Northeast Brazil***

ASs assist in assessing both equity, as well as economic and financial situation of entities, turning decision-making process safer. BS is one of the main ASs and aims to show economic, financial, equity and accounting situation of an entity, in a given period, in which accounts are grouped into assets, liabilities and net equity (Brazil, 1976). In an analysis of BSs and Explanatory Notes (ENs) of Northeast FIs, it was observed that the eleven (11) institutes show intangible assets related to computer systems in *Softwares* account. Nonetheless, only five (5) FIs account for their intangible assets in trademark and industrial patents account, as shown in Chart 3. In addition, institutions that make comments in their ENs regarding intangible assets, and those that do not register in the ASs/FSs, considered here as "Without Disclosure (W/D)" are identified.

Chart 3. Intangible Assets Registration in BSs of the Northeast FIs

Institutes	Intangible Assets		
	Accounting / Financial Statement	Softwares	Trademarks, Rights and Industrial Patents
IFAL	BS	X	
	EN	X	
	W/D		X
IFBA	BS	X	
	EN		X
	W/D		X
IFBAIANO	BS	X	X
	EN		X
	W/D		
IFCE	BS	X	X
	EN	X	
	W/D		
IFMA	BS	X	
	EN		
	W/D		X
IFPB	BS	X	
	EN	X	
	W/D		X
IFPE	BS	X	X
	EN	X	
	W/D		
IFPI	BS	X	X
	EN	X	X
	W/D		
IFRN	BS	X	X
	EN	X	
	W/D		
IFS	BS	X	
	EN	X	
	W/D		X
IFSERTÃO-PE	BS	X	
	EN	X	
	W/D		X

Source: Prepared by the authors from e-sic/CGU (2019).

Based on analyzed ASs, it was found that all of these FIs register their software in the equity accounts identified as Software. However, only IFBAIANO, IFCE, IFPE, IFPI and IFRN measured, accounted for and evidenced intangible assets in trademarks, rights and industrial patents accounts. Therefore, other institutes (IFAL, IFBA, IFMA, IFPB, IFS and IFSERTÃO-PE) do not disclose these assets in their ASs.

Furthermore, no additional information was observed in the IFMA's ENs regarding IP. In ENs of IFAL, IFCE, IFPI and IFRN there is only one general information that says that intangible assets are measured or valued based on acquisition or production value, minus the balance of the respective accumulated amortization account and the accumulated amount of any value loss that has been incurred over its useful life due to impairment.

Thus, IFAL, IFCE, IFPI and IFRN are in compliance with NBC TSP 08 (CFC, 2017b), which comments on amortization allocation of intangible assets over their useful life from the date that is available for use, and concludes when the asset is held for sale, or derecognized, whichever comes first (IFAL; IFCE; IFPI; IFRN, 2018; CFC, 2017b).

IFBA's EN states that an intangible asset is composed of software, brands, rights and industrial patents and this subgroup is still in evaluation process considering the need for information that demonstrates that it is reliably an intangible asset, given the separability criterion or result of contractual/legal right, as well as useful life definition, determinable or indeterminable, for adoption of reclassification measures and economic update (IFBA, 2018).

According to NBC TSP 08 (CFC, 2017), there are difficulties to qualify the recognition of internally generated intangible assets, as it is necessary to identify whether the asset will generate future economic benefit, as well as to specify its value. This is one of the problems that NITs face, since there is a lack of management and control of expenditure on inventions that are necessary to obtain a minimum cost, as well as direct expenses with patents production (Ferreira, 2019). In the research carried out by Araújo and Leitão (2019), it was demonstrated that most public servants report that information system structure does not help NBC TSP 08 adoption (CFC, 2017b), as there is a need for a system that allows efficiently recording and processing of information. In addition, systematic control of financial flows is necessary to better manage investments in innovation in these institutions.

With respect to IFBaiano's EN, there is an internally produced asset, but no information has been identified regarding its measurement and disclosure. Accordingly, there are no record on the asset, which are recognized as a diminishing equity variation (IFBAIANO; 2018). It is worth mentioning that in BS, only the value of R\$120.00 is registered in the Trademarks and Industrial Patents account. It is observed that even when NBC TSP 08 (CFC, 2017b) guides how to measure the book value of intangible assets, IFBAIANO has not shown its costs in accounting, and therefore has difficulties in valuing assets.

One of the possible explanations for this problem is information lack from professionals, as it was found in the research carried out by Araújo and Leitão (2019), that accountants studied in the research have a reasonable or weak knowledge degree regarding NBC TSP 08 application (CFC, 2017b). This is due, in part, to lack of training related to the theme, since the standard has complex elements and requires institutional support to assist in this specific knowledge transmission.

In the IFCE EN, intangible assets totaled R\$945,184.02 in 2018, and consisted of computer systems. Out of this total, an amount of R\$14,536.33 is classified in the Trademarks, rights and industrial patents account (IFCE, 2018). This latter value may be associated with use rights that has been assigned or valued software trademarks or valued patents, but that have not yet been converted into software.

In the IFPB, it was defined in the Internal Plan for Equity Accounting Procedures (PIPCP) that recognition, measurement and disclosure of software, brands and patents, with their respective amortizations, revaluation and impairment value became mandatory as of 01/01/19. However, until the end of this research, it was observed that only software and accumulated amortization were recorded as intangible assets (IFPB, 2018). According to ENs, intangible assets with an indefinite useful life have not yet been tested and, therefore, impairment losses have not yet been recognized. As for software, they represent about 99% of the group's total value (IFPB, 2018).

Regarding IFPE, in its Management Report, specifically in the intangible asset account, there is an amount of R\$2,656,386.57, whereas in the software account it has an amount of R\$2,646,138.75, which has already been reduced the accumulated amortization value of software (R\$150,578.58), and in the trademark, rights and industrial patents account is registered the value of R\$10,247.82 (IFPE; 2018). However, there is no information about this amount in the trademarks, rights and industrial patents account in EN, it only informs that the software is recognized at the acquisition price and accounts for 0.65% of total assets, disregarding amortization. It also points out that the methodology of constant quotas is used to calculate amortization (IFPE; 2018).

According to IFPI 2018 Management Report, a vast majority of intangible assets are related to software. However, trademarks, rights and industrial patents account only disclosure R\$795.00 (IFPI, 2018). This institute does not address details regarding the registered amount accounting in BS brands, rights and industrial patents account in its ENs.

In IFRN scope, there is evidence of values of R\$348,803.88 for software and R\$120,263.44 for trademarks, rights and industrial patents (IFRN, 2018). According to IFRN's EN, amortization procedures for intangible assets started in 2017, and the method adopted is that of constant quotas. It was segregated into two accounting accounts, one of which is software with a defined useful life, whose life is defined by its license term, and the other is software with an indefinite useful life. The first software is subject to amortization and the second one not. In this EN, there is no mention of the amount registered in trademarks, rights and industrial patents (IFRN, 2018).

According to IFS ENs, all intangible assets are software-related, both with defined and indefinite useful lives (IFS, 2018). Regarding the ENs of IFSERTÃO-PE, there was an increase in intangible group balance, due to software acquisition on a certain campus (IFSERTÃO-PE, 2018).

It should be noted that STIIs must recognize intangible assets in accordance with NBC TSP 08 (CFC, 2017b). Although there are guidelines from the aforementioned NBC, it was observed that measurement/ monetary valuation of intangibles, particularly patents, is still incipient in STIIs, due to knowledge lack and/or difficulties in understanding and applying existing methodologies (Ferreira, 2019). Furthermore, according to Pakes, Borrás, Torkomian, Gomes and Silva (2018), one of TT barriers among universities and companies is the operational difficulty in valuing technological process, for which accounting is strategic and fundamental, considering its role of measuring, recording and evidencing, as



well as, controlling the facts that provoke equity changes. Thus, accounting science is a strategic element to assist in measurement, recording, and disclosure, and should be considered, based on the NBCs, and in STIIs innovation policies. In addition, it is highlighted that recognition, measurement and disclosure of intangible assets in a proper way provide greater transparency in relation to public resources use (Araújo & Leitão, 2019).

It is worth mentioning that assessment and valuation of intangible assets became a great foundation for STIIs growth, as they facilitate invention negotiation for the productive sector. Thus, equity measurement and control can contribute to disclosure of an organization's equity integrity, in addition to valuing the invention, which is one of the fundamental stages for negotiation and TT process (Ritta&Ensslin, 2010).

## **5. Final considerations**

The research aimed to analyze whether Intellectual Property assets of Federal Institutes (FIs) of Northeast Brazil are being measured, accounted for and evidenced in the Financial Statements (FSs) of these Scientific, Technological and Innovation Institutions (STIIs). To this end, a survey, exploratory, descriptive, bibliographic, documentary and qualitative research was carried out, in order to analyze scientific, legal and institutional documents of Northeast FIs.

From this research, it was found that most IP assets generated by Northeast IFs are not measured, accounted for and evidenced in STIIs' FSs. In addition, it was observed that despite the majority of Northeast FIs' NITs have innovation policies that support intellectual protection of inventions, accounting records of granted patents and TT, they are still incipient.

Notwithstanding advances in standardization, one of the causes of this problem may be knowledge lack of the NBC TSP 08 (CFC, 2017b) by public servants, which hinders standard operationalization. Therefore, there is a need for training public servants involved in the sectors responsible for managing innovation policies and accounting records. Furthermore, the importance of systems that contribute to control of invention expenditures and that subsidize reliable information in order to support STII negotiation process is highlighted.

In addition, it was found that there is a low registration in trademarks, rights and industrial patents account in BSs. The absence of structured accounting procedures in FIs' policies was observed. Despite most Northeast FIs having innovation policies, accounting procedures, which are key tools to support measurement, recording and disclosure of IP assets are not included in their guidelines.

When analyzing how intangible assets valuation and IP assets accounting are inserted in Northeast FIs' innovation policies, it was noticed that the innovation policies do not make an approach to this theme, which stands out as one of the factors that may contribute to hamper TT. There is a normative formalization lack regarding accounting aspects in them, which could assist in the operationalization of recognition, and TT negotiation for the productive sector.

The research was limited to analyzing innovation policies regarding accounting aspects, as well as IP assets records in the FSs within Northeast FIs scope, namely: IFAL, IFBA, IFBAIANO, IFCE, IFMA, IFPB, IFPE, IFPI, IFRN, IFS and IFSERTÃO-PE. Through data analysis, it was possible to identify that



four institutes do not have innovation policies: IFBAIANO, IFMA, IFPI and IFS. It is hoped that the results of this research can broaden the discussion for the need to create an innovation policy that includes accounting procedures to support valuation process, with a view to providing a continuous improvement in the process of negotiation and TT for innovation.

Accounting helps to monetize the result of a work done and enables TT to introduce an innovative national technology to the market. It turns out to be a competitive advantage for a receiving company, since it can add value to services offered through a technology that gives greater increment to products that already exist. In order to facilitate this transfer, this research will serve to understand difficulties created by the legislation in order to FIs show their IP assets in their ASs. Thus, in order to guide internal accounting procedures of these institutions, it is suggested to include normative aspects referring to such procedure in innovation policies, since disclosure absence in FSs can have negative impacts on negotiations, as there is no reference value.

Finally, it is recommended, as a future investigation, to carry out researches aimed at creating a proposal for accounting procedures to be included in Northeast FIs innovation policies, so that accounting gaps can be addressed within the scope of these policies in order to favor disclosure of integral public equity in BSs.

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# **THE IMPORTANCE OF THE SCHOOL / HEALTH PROFESSIONAL RELATIONSHIP IN THE DEVELOPMENT OF USER CHILDREN AT THE INFANTO-JUVENILE PSYCHOSOCIAL CARE CENTER OF CAMPO GRANDE, MS - BRAZIL**

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## Abstract

*Children with severe mental disorders or dependent on psychoactive substances tend to suffer several challenges, including their learning. This reality is present in the lives of patients at the Children's Psychosocial Care Center in the city of Campo Grande-MS, where they are daily accompanied by a team of qualified professionals in order to help in their recovery. Among them, there is the role of the teacher who will provide methodologies so that the student does not suffer consequences in his development, at the same time that he can provide his recovery. Thus, the objective of the undergraduate thesis is to verify how the Centro de Atenção Psicossocial Infantojuvenil (CAPSij) assists child users together with the role of the regular school for the child's biopsychosocial development, and of how this partnership between school and health professionals takes place with the intermediation of the patients' families. This study will use a quantitative-qualitative and exploratory approach with children in different age groups and psychosocial situations, together with the professionals involved in the Education and Health agencies in the municipality of Campo Grande, Mato Grosso do Sul. The field research took place at the time of the pandemic due to Covid-19, therefore, all data collection was in medical records of CAPSij, with health professionals who care for children in the Service Centers and with the teachers of these children from the Regular School through online interviews, respecting the social isolation and the guidelines of the World Health Organization (WHO), with the objective of collecting the data that respond to the objective of this research and to verify how the relation between the education and health agencies occurs, with its teaching and learning process that, due to psychosocial diseases, end up suffering with difficulties in their learnings.*

**Keywords:** Children; Mental health; Teaching and learning; CAPSij.

## 1. Introduction

Over time, the concept of childhood has changed, showing transformations and different positions in society. In the 12th century, children were subjected to indifference and some cruelties, sanitary conditions were precarious collaborating with the illness process, since many lived in a single room, without airing or sun, collaborating for the critical picture of infant morbidity and mortality (ARAUJO, et al, 2014). “Even in this period, women, in the parturition process, were assisted by inexperienced midwives and, afterwards, their children were cared for by slaves, called wet nurses” (ARAUJO, et al, 2014, p. 1001). We realized that during this period, due to the conditions of the time, lack of hygiene, healthy food, poor sanitation conditions and other precarious conditions, allowed the transmission of diseases and favored the children's illness (ARAUJO, et al, 2014).

Understanding modern childhood as a social construction, characterized by moral values from the Ariès era (1978), it portrays that it was from the Industrial Revolution in the 18th century that a new way of seeing children was born. Then came the first public policies aimed at children, collaborating for a new concept, that of childhood, and for the levels of infant mortality to decrease.

Between the 18th and 19th centuries, the child begins to be recognized as a biopsychosocial being (Ariès, 1978), with rights as a citizen who demands protection and assistance, ceasing to be seen by a model only centered on pathology.

With these changes, public policies also appear after claims and historical processes, always thinking about the human rights and health of children. In this context, child protection programs were implemented in order to provide assistance and follow-up and guarantee health in an expanded way.

The reality of children with severe mental disorders or dependent on psychoactive substances, tends to be expressed in the experience of several challenges, which include the daily concern involved in recovering their health, detoxifying from addictive compounds, and yet, maintaining their learning avoiding that the treatment does not cause harm and educational delays. According to Mielke et al (2009), the psychosocial mode, approached by the Centro de Atenção Psicossocial (CAPS), which focuses on helping and recovering these children, implies the way of thinking and welcoming the person who goes through psychological suffering, making it possible to understand it from their existence-suffering, and not just from their diagnosis and the symptoms presented. In 2001, at the III Mental Health Conference, the Psychosocial Care Center was defined by the Ministry of Health as:

A daily care service designed to care for children and adolescents who are severely psychologically impaired. This category includes patients with autism, psychosis, severe neurosis and all those who, due to their psychic condition, are unable to maintain or establish social ties (BRASIL, 2004, p.23).

Subsequently, on Dec. 23, 2011, Ordinance No. 3088 was included to assist people with needs arising from the use of alcohol and other drugs in all CAPS and their modalities.

According to the *Secretária Municipal de Saúde Pública* (SESAU) in the municipality of Campo Grande, there are 5 CAPS units divided into “Mental Health”, “Therapeutic Residency”, “Adult Reception Unit”, “Post Trauma” and “Interdisciplinary Adult Ambulatory Units and Children and Youth”. Among these centers, the unit responsible for providing assistance and treatment to children afflicted by mental disorders and chemical dependency is the *Centro de Apoio Psicossocial Infanto-Juvenil* - “Dr. Samuel Chaia Jacob” (CAPSi), located at Avenida Manoel da Costa Lima, 3272 - Campo Grande, MS, which has a team of professionals composed of 01 Psychiatrist, 03 Psychologists, 02 Occupational Therapists, 01 Speech Therapist, 01 Psychopedagogue, 01 Social Assistant, 01 Pharmacist and 01 Nurse.

Therefore, this work will be developed from theoretical studies and data obtained through the observation of the experience of children enrolled in schools in the regular period and who also require CAPSi care, aiming to bring up a reflection on the importance of the partnership of two fundamental bodies for the psychosocial development of such children in need of care: the Regular School with the administration and teachers aware of the reality and situations of their students, and CAPSi, with professionals qualified to help and guide patients and their families.

Regarding the incidence of mental disorders among children, epidemiological data reveal, worldwide, “a prevalence in the range of 10 to 20%, of which, between 3 and 4%, there is an indication of intensive care” (BRASIL, 2005, in: BELTRAMI; BOARINI, 2013)). We know that these data reveal that mental disorders

are not only diseases of adults, but also of children. In the words of Guarido:

Taking children into account, there is currently a multiplicity of psychopathological diagnoses and therapies that tend to simplify the determinations of childhood suffering. What we recognize as a result of this type of practice is that an increasing number of children at an ever earlier age are medicated in order to remedy the children's symptoms, without considering the context in which they present themselves (2010, p. 29).

A daily care service is created in the municipalities to care for children who are psychically impaired. Therefore, we emphasize the importance of making this area visible, in order to provide children with an effective right, not only to care, which respects their developmental differences and specific needs, but also, the right to education and health as it is presented in all child legislation.

## **2. The child and its development**

The human being never stops developing, always evolving his ideas and overcoming challenges. School, for example, is one of the first places where children start to develop their learning, such as writing, language, the social environment, games and rules.

This learning can be developed through different situations and objects, such as games, toys, games, make-believe, books, problem situations. In which prepares you for challenges within your day to day. It is from the interaction with the environment, determined by an intentional and directed act of the teacher that the child learns (Vygotsky, 1998). For Vygotsky, the child learns and then develops, therefore, this development occurs through the acquisition that the human being builds socially throughout its history.

### **2.1 Learning**

Learning consists of a process of acquiring knowledge, values, attitudes and skills, capable of being acquired through experiences, studies and teaching. Vygotsky (1998) points out that, through the learning process, the individual acquires new ways of thinking and acting consciously, dominating the psychomotor, cognitive and affective.

Early childhood has a fundamental characteristic role for the development and formation of the child, as it is at this stage that it constitutes different stimuli intermediated in the social environment in which it is inserted. In addition, "childhood presents itself as a crucial phase for the development of a motor repertoire that will favor the improvement of other skills throughout adulthood" (Fin; Barreto, 2010, p.5) Therefore, the offer of jobs that involving psychomotor activities can be used to make great progress in their development and learning process.

According to Giusta (2013) the concept of learning emerged from the investigations of Psychology, from research carried out based on the assumption that all knowledge comes from experiences. This means that the individual is willing to form through the impressions of the world, giving way to his knowledge, formed by records of events that occurred in the person's life.

For Vygotsky in his studies on the learning process, the relationship between the adult and the child makes it possible to transmit his thoughts, culture and experiences. About this:

Each role in a child's cultural development appears twice: first at the social level and later at the individual level, first among people (interpsychological) and then within the child (intrapsychological). This applies equally to all voluntary attention, to memory, to concept formation. All higher mental actions originate as real relationships between people (VYGOTSKY, 1978, p. 57).

For Vygotsky's (2010) understanding, learning begins long before the school learning process. The child will never start his school trajectory without a starting point, he will take a history and acquire new learnings, with different characteristics being the learning that comes before the child is of school age and what he acquires in school institutions. Therefore, development and learning are correlated from the child's first moment of life.

The set of capacities that the child acquires through its social and cultural acquisitions, are characterized as a "capacity set" and separated into two levels that the child goes through in his life stage of development. First, the level of potential knowledge, called by Vygotsky (2010), is the ability in which the child obtains to perform tasks with the help of a more experienced person, and thus starts to acquire the level of real knowledge, in which the achievement of tasks it is no longer necessary to have intermediation by a more experienced person.

Vygotsky (1991) points out that learning has interaction as an essential point, when the child is able to put it into practice through mediations and interactions with other individuals is when development actually took place. Therefore, he points out:

[...] Learning awakens several internal developmental processes, which are able to operate only when the child interacts with people in his environment and when operating with his peers. Once internalized, these processes become part of the child's independent development acquisition (VYGOTSKY, 1991, p.77).

Thus, the author's studies demonstrate that man is a combination of a biological, historical and social being, in which being included in the environment of the interactionist partner will effectively develop his biopsychosocial. Vygotsky et al (1989) believes that individual characteristics and even their attitudes are impregnated with exchanges in the collective, that is, even if the individual becomes individual, his characteristics as a human being were built under interactional relationships with others human beings.

## ***2. 2 The interaction process for learning***

As we previously discussed, Lev Seminovitch Vygotsky (1896-1934) wrote and supervised several works related to the interaction of individuals with the environment and the importance of experiences mediated by the world so that we understand the reality in the social and cultural environment, assigning meanings to things and evolve the cognitive.

In his theory on the development of learning, children's attitudes in their first moments of life already reflect their own meaning in the social behavior system in which they are portrayed through the cultural environment in which the child is inserted. VYGOTSKY (1989) says that the child's path to the object is linked to a person, this structure being a product of the development process between individual and social history.

For the author, the child is a specific social being in which his/her cognitive development obtains through the child's interaction with another adult, transforming the second person into a carrier of all the cultural messages in which he/she is involved, thus, his/her development permeates the interactions with other people and reflects in the engagement of new activities, obtaining an evolution in their learning. In addition to social interaction with other people, there is also the use of tools that can assist in the process of interaction with the child, in which objects are created and modified to connect with reality, in addition to helping in the relationship with the world.

Therefore, the school and the educator have a fundamental role in the child's interaction, since the participation of students in the classroom can be a factor that interferes in their teaching-learning process, since it is through the interaction between educator and student that there may be contributions to your cognitive development. Consequently, the teacher must always be attentive to the different levels of development that will be in the classroom, since each child has their own unique learning.

The classroom should be the place where the child has structural and didactic-pedagogical conditions to foster their learning, transforming a healthy school environment of dialogues and instruments so that their interaction, their social relationship and their learning have an evolution in their teaching-learning.

### ***2.3 The right of the child***

In order to guarantee the necessary political and social right for decent conditions of Education, they are guaranteed in the Brazilian Constitution promulgated on October 5, 1988, consolidating a Democratic State of Rights.

Having rights means that they apply equally to all children and adolescents. Everyone has the same rights. These rights are also connected, and all are equally important – they cannot be taken away from children and adolescents.

In the 1<sup>st</sup> Principle of the Universal Declaration of the Rights of the Child states that every child will enjoy all the rights set out in this Declaration.

All children, absolutely without any exception, will be creditor of these rights, without distinction or discrimination due to race, color, sex, language, religion, political or other opinion, national or social origin, wealth, birth or any other condition, either yours or your family's (UN, 1959, p. 01).

Therefore, we verify that the child has rights. Right to education, right to health, right to family life, etc.

#### **2.3.1 – The Education Right**

The Right to Education is part of a set of Social Rights determined by the Federal Constitution of Brazil,

in which it aims at fundamental rights to maintain equality, protection and guarantees from the State to society.

The Brazilian Constitution in its legal text, in Article 6<sup>th</sup>, guarantees your rights: Education, health, work, housing, leisure, security, social security, maternity and child protection, assistance to the destitute, are rights and social, in the form of this Constitution (BRASIL, 1988, n/p). Specifying the document on Education as a duty of the State, the Federal Constitution, in its article 205<sup>th</sup> states that:

Education, the right of all and the duty of the State and the family, will be promoted and encouraged with the collaboration of society, aiming at the full development of the person, their preparation for the exercise of citizenship and their qualification for work (BRASIL, 1988, n/p).

According to Bittar (2003, p.30) the Federal Constitution underwent a collective effort by segments to be assured, “[...] the State's principles and obligations to children”. Enabling parliamentarians to direct Brazilian Laws for children and their right to education. In this way, “[...] the State's duty towards Education will be carried out by guaranteeing the provision of crèches and pre-schools to children from zero to six years of age” (BRASIL, 1988), thus, the daycare centers that were previously linked as a social assistance center, have become the primary responsibility of Brazilian Education.

To complement the Federal Constitution, two years after the segment, the Child and Adolescent Statute (*ECA*) - Law 8,069/90 was approved, which inserted the child as a human rights being. In Article 3<sup>rd</sup>, the fundamental rights inherent to the human person are ensured, so that they have access to opportunities for “[...] physical, mental, moral, spiritual and social development, under conditions of freedom and dignity” (BRASIL, 1994a).

In 1994 to 1996, the Ministry of Education published a series of documents entitled “National Policy for Early Childhood Education” in which it drew up pedagogical guidelines and human resources to expand the offer of vacancies and promote improvements in the quality of attendance at school education. In addition to these documents, the 1996 National Education Guidelines and Bases Act stands out, which refers to school levels together with the inclusion of Early Childhood Education as the first stage of Basic Education, which ends early childhood education as a comprehensive promotion of children up to six years of age, complementing the action of the family and the community. (BRASIL, 1996).

For Barreto (1998), despite the great progress in legislation to enforce respect for the recognition of children in their right to education, it is also important to consider the challenges imposed for the effective fulfillment of these rights, which can be summarized as central issues: access and quality of care. In terms of access, the author states that in recent decades, the child's entry into the daycare center is still not desirable, since low-income families are having fewer opportunities than those of a higher socioeconomic level. In order for this purpose to be fulfilled, Law No. 10,172/2001 - National Education Plan was approved in 2001, whose main objective is to establish goals for all levels of education, thus reducing social and regional inequalities in which says about the entry and permanence of children and adolescents in public education.

Currently, the Common National Base Curriculum (*BNCC*) is the agenda of important debates about the



country's education. The document approved by the Ministry of Education, in 2017, determines the competences (general and specific), skills and learning that all students must learn in the stages of basic education - Kindergarten, Primary and Secondary Education. The Base is not considered a curriculum, but a set of guidelines that will guide school teams in formulating their local pedagogical curricula. Therefore, the creation of this common base has been correlated since the Federal Constitution of 1988, from the promulgation of the Citizen Constitution, presented above, as well as with the National Education Guidelines and Bases Law (*LDB*) and the National Education Plan (*PNE*).

### **2.3.2 - The right to health**

The Statute of Children and Adolescents (BRAZIL, 1988) assigns to the Unified Health System (*SUS*) the role of promoting the right to life and health, with the implementation of public social policies that allow birth and healthy development, health protection and recovery (Article 7<sup>th</sup> and 11<sup>th</sup> of the *ECA*, 1990). As a result, *SUS* assumed health responsibilities towards children, adolescents and their families through Law 8,080/1990 and 8,142/1990.

Care for the child provides access for the promotion of physical, mental and social well-being. Strategies aimed at promoting healthy growth and development, sexual and reproductive health, mental and emotional health and the reduction of violence and accidents stand out. Therefore:

In the discussion of health as a right, it is essential to strengthen a model of care organized based on health care networks, in a manner agreed between the different spheres of management and inter-sectorally articulated, according to the specificities of each region, to respond to the needs of the child and adolescent population explicit in the analysis of the health situation (BRASIL, 2010).

In this way, the connection between the Child and Adolescent Statute (*ECA*) and *SUS* provides for the rights of the child to be respected, following in their recovery health, protection, prevention and quality access. Therefore, when bringing the implementation of *SUS* in the 1990s, the unique model of health adopted by Brazil brings a new concept of health care, in a way:

That the Unified Health System (*SUS*) was created to offer equal care and care for and promote the health of the entire population. The System is a unique social project that materializes through actions of promotion, prevention and health care for Brazilians.

Infant-juvenile mental health services include actions such as welcoming, listening, caring, enabling emancipatory actions and improving people's quality of life, in order to have full participation and inclusion in society, in which each singularity and the construction of the subject in its proper conditions are taken into account.

## **3. The Child and Youth Psychosocial Care Center and the Regular School**

The Child and Youth Psychosocial Care Centers (*CAPS*) is formed by interdisciplinary teams, whose main objective is to assist people with severe and persistent mental suffering or disorders, including those that have developed through the constant use of alcohol and other drugs, as well as experiencing clinical



situations that make social life impossible.

Its performance is in large and small cities across the country, in situations of crisis and/or psychosocial rehabilitation processes. *CAPS* is a form of strategy that manages and increases the demand for care in the mental health area and against the effect of alcohol and drugs, identifying more fragile and vulnerable populations in which they need a different and more focused approach.

*CAPS* seeks to be present in collective spaces, in which it will articulate with other health care points and other networks, offering professionals such as doctors, psychologists, social workers, in addition to professionals more specific to each demand in the region.

The care transmitted by *CAPS* is developed through therapeutic projects with the patient and his family. The coordination of the entire treatment process is the sole responsibility of *CAPS*, which guarantees full participation in the treatment process and the longitudinal monitoring of cases.

Children and adolescents have their right to education and health guaranteed, therefore, when dealing with mental health, addressed by *CAPS*, it is essential to ensure proper participation and importance in mainstream schools. According to the Ministry of Health (2014, p. 39):

Schools are privileged environments for the development of children and adolescents and their families, both in promoting protective factors and in detecting risks and reducing harm from psychosocial problems. Since most of the Brazilian children and adolescents are concentrated, school establishments add diversity and singularities, potentialities and significant resources for the production of health, the guarantee of integral protection and the development of people under the principles of autonomy and emancipation.

Therefore, it is important that there is communication between *CAPS* and regular schools, so that there is no negligence for both parties in situations of street, institutional reception, socio-educational measures for hospitalizations and in other situations of vulnerability.

#### **4. Research Methodological Path**

This work was carried out through a field research, in which the collection of data and medical records were obtained in September 2020 at the Center for Psychosocial Care for Children and Adolescents (CAPSij) - "Dr Samuel Chaia Jacob", which has a team of professionals composed of psychiatrists, psychologists, speech therapists, occupational therapists, pharmacists and nurses. Another place that was also part of the research procedures was the regular school in which the child was enrolled, also being a locus of the research. The research took place in the pandemic period due to COVID-19, therefore, it was carried out according to the security recommendations of the Ministry of Health and WHO, and the contact with professionals was carried out online through Whatsapp or via phone call.

Data collection was carried out in two stages, the first stage being in children's medical records within CAPSij, in order to obtain procedural data on treatments and diagnoses, together with contacting the technicians responsible to acquire more information from the patient. Three male patients were selected,

aged 8 years, 9 years and 10 years, named as: Subject 1, Subject 2 and Subject 3, respectively to protect the children's identity.

**Subject 1** has the CAPSij speech therapist as a reference technician, who works for 6 years in these procedures. The professional accompanies the patient for 2 years and reports that the regular school maintains a satisfactory contact with the health institution, sending the semi-annual reports or when requested, always being ready to provide the necessary questions that arise during the treatment, however, the school does not send activities to be carried out within the CAPSij, since this is not the primary obligation of the institution, therefore, school monitoring is not carried out, resulting in pedagogical activities that may be offered at the health institution are of total responsibility of the reference technician, without interference in the content worked in the school. There is also a report of the family's satisfactory participation with contact with health and education professionals, with direct communication, participation in meetings and lectures and intermediation between both professionals in the area.

**Subject 1** started his first treatment at the institution in 2014, due to suspicions of abuse suffered by his older brother, however, in his medical records there was a report that the patient did not present any symptoms of trauma, and that the source of the referral to CAPSij was a spontaneous search by the parents themselves after the report of the abuse suffered by the neighbor who was at the same moment as the patient was. There is also an observation that the child had a good performance in the classroom in the regular school, and for these reasons, after some evaluations and consultations, his treatment was completed and the same dismissed.

In 2018, the parents of this patient again sought the help of health professionals, reporting new behaviors that the student had acquired. He presented childish speech, fear and nervousness so that he could not suffer contradictions. School reports showed that the student was discouraged and tired, but was punctual in activities and organization, had autonomy and showed good behavior, but avoided contact with his colleagues and teachers, which made his literacy process difficult because he refused reading to the teacher. After consultations by professionals, the child (subject 1) was diagnosed with depression, Oppositional Defiant Disorder (ODD) and attention deficit hyperactivity disorder (ADHD). This diagnosis was sent to the school and its attendance began at the Specialized Education Service.

In 2019, still following the treatment *at CAPSij* with its reference technique and the necessary medications, there being no more signs of depression, there was instability in his behavior, and for some calls reported as aggressive and provocative refusing to perform the treatment with medications, but according to the regular school through reports, presented a satisfactory performance in his learning, being frequent and interested, socializing more and with a more appropriate behavior, with only some difficulties in his reading and writing. Finally, in 2020, an atypical year due to the COVID-19 pandemic, **Subject 1** still continues with treatment at CAPSij, but without further evaluations from the regular school, as face-to-face classes were suspended during the year. The patient kept his appointments obtaining the same diagnosis and medication as in previous years, but showing signs of anxiety and depression, refusing to leave the house without his mother's company and to resume medications. Upon contacting **Subject 1**'s regular school, the situation pointed out by the conducting teacher and the teacher at the Multifunctional Resource Room (*AEE*), brought positions of behavior similar to that presented by *CAPSij*, with a discrepancy in the

evolution obtained in the year prior to the who reports on cognitive development, as an agitated student, with learning difficulties and with a certain difficulty in making friends with his classmates. There was also an observation that both the regular school when asking for reports and documents necessary for the student's knowledge, and *CAPSij* were readily available to help and send what is necessary so that the education carried out in the classroom has knowledge and help in the treatment in both locations. With this partnership between the regular school and *CAPSij*, there was also a facilitator for the family to be the intermediary for both parties and made it possible to be present in the child's treatment.

Until the present article the patient is still under treatment.

**Subject 2** has the *CAPSij* psychologist as a reference technician who has been working on these procedures for eight years, and who has been accompanying the student since September 2020, the same period that he performed his first welcoming procedure. The patient was referred for treatment through the request of the regular school, where he is enrolled in the 3<sup>rd</sup> year of elementary school. The patient presented symptoms observed by the health professional, such as anguish, anxiety, discouragement, isolation, emotional crying with constant sadness, difficulty concentrating, agitation, increased appetite and reports of suicide attempt, exacerbated sexuality and insomnia. The family is always present in the group attendance offered by the responsible psychologist and in the follow-up consultations and maintains a partnership with the highly supportive professionals, always intermediating positions with the regular school teachers. When we got in touch with the conducting teacher who was present in the student's education 2 years ago, she points out that **Subject 2** is easy to relate to colleagues and teachers, but appears tearful and sad in some days, usually missing for weeks and when contacting the mother, it justifies that the student is not feeling well. Despite this behavior, the teacher characterizes the student as a quiet and well-educated child, however, there is always the need to have individual attention to carry out the activities, being frequently asked and placed near the teacher's table so that, requested activities. In spite of this, his cognitive development is in accordance with his age/grade and he finds it easy to relate numbers with quantities, together with mathematical operations.

**Subject 3** is also accompanied by the same reference psychologist, who has followed his treatment since 2018, when he started the welcoming process at *CAPSij*. The first behaviors that the child presented immediately in the welcoming assessments and in the reports presented by the family, showed a child with a lot of irritability, difficulty concentrating, agitation and extreme aggression, with episodes of threats with sharp objects against his sisters, which caused referral by the regular school for observation and treatment. The psychologist (reference professional) reports that the mother is always present in the consultations, providing great support for the treatment. According to the school reports sent to *CAPSij*, the child is literate, with reading and writing scheduled for the age group and year, but is dependent and requires direct interventions in all activities, as it changes behavior easily and gets involved in conflicts with colleagues and teachers, in addition to being bored with ease and difficulty in getting involved in group activities. During these years of care, the monitoring provided to the child has been weekly with the therapeutic groups along with medications prescribed by the *CAPSij* psychiatrist, with small improvements in their behavior.

According to the conducting teachers who have been monitoring **Subject 3** for 1 year and 9 months at the regular school, the student's behavior when he started treatment at *CAPSij* was one of mood swings, showing aggression and difficulties in accepting the rules and agreements, continuing these attitudes even after the care provided by the Attention Center. When characterizing the student's social environment, it is reported that he is an introverted child with difficulties in “maintaining, making and establishing interpersonal relationships” (conducting teacher), however, in his cognitive process he did not present any difficulties, in the way that his learning it occurs, most of the time, through auditory stimuli of the explanations of the content worked in the classroom and also through the repetition of the student's action. The school also states that there are no direct contacts between *CAPSij* professionals and that the family does not carry out this intermediation process, which hinders the student's behavioral development process, which will influence the schooling process.

### **Some final considerations**

The study carried out points to the important correlation between the relationship between educational institutions and *CAPSij* in the ideal development of children who are served by both services, to continue their teaching and learning process, observing the methodologies used for learning child and the care of *CAPSij*.

It is clear that each part has its importance in the psychosocial development of children and requires differentiated care from the student. The two bodies have complementary functions, such as the regular school in its role of administration and with teachers trained to develop their pedagogical according to the reality and situation of their students, and *CAPSij* with professionals qualified to work the emotional and social of their patients and family members, since these two factors are correlated in the life of the human being.

In this way, the present work brought the reality of children with different diagnoses and treatment time, in order to emphasize the importance that the organs have in providing an affective education environment, respecting the differences in development and in the social relationship, as well as the right to education and health.

The analysis of the cases allows to conclude that the adequate correlation of the institutions promotes an increase in the quality of education. Mainly because the partnership between the organs and the children's family promotes the integrality of the human being, encouraging their development in all functionalities, whether intellectual, emotional or health.

Even so, it is extremely necessary to continue studies and research that relate the agents to determine what is the best form of institutional relationship that promotes the best use in the education of children. It should be noted that even though it is not the focus of our research, the family is decisive for the emotional adjustment of the child, with family stability being a primary factor for the child to be able to concentrate on learning activities.

We can also conclude that the importance of the partnership between school and health institution can enhance the school development of children through interventions in the family, evidencing the performance of the school as a space for health promotion. The importance of developing intersectoral

health promotion actions allows health and education professionals to expand their potential for action and reflection, extrapolating actions in quality without losing their specificity.

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# **Transversal Diagnosis of the Panorama of Professional Education: A Case Study of the City of Itaporã – Mato Grosso do Sul**

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## Abstract

*This case study aims to identify the demand for professional education courses in the city of Itaporã, in the state of Mato Grosso do Sul, in the year 2020, offering a cross-cutting diagnosis of this educational panorama; for this purpose, the technique of guided interview in loco was implemented with the action coordinating agents designated by the municipal administration. All those involved were aware of their free and voluntary collaboration. During the entire collection phase, the information was recorded through a free association chart which, later revised, gave basis to the identification that in the disclosure phase there is no time to contact the possible students taking into account that, besides the districts, the municipality aggregates a vast rural region. In addition, the fact that the course is offered only at night, ends up discouraging the participation of some potential students who, despite showing interest, need to pay attention to their labor routines. It is concluded that a greater concern is needed to create a database of course graduates in order to establish a periodic sense capable of identifying professional life after the course, in addition to profiling the demand for skilled labor in order to detect which training is important at the moment.*

**Keywords:** Professional Education; Industry; Commerce; Labor Market.

## 1. Introduction

This case study aims to identify the demand for professional education courses in the city of Itaporã, in the state of Mato Grosso do Sul, in the year 2020. During the study, it is also questioned to analyze the profiles, areas of activity, number of vacancies offered, levels of education and demands of the courses offered.

In this path, we seek to analyze the local productive arrangements and verify whether the choice of courses offered meets this principle or the marketing principle. In addition, it is also brought to the surface the concern with the question of divulging the offer of these demands to the population of the studied municipality.

Continuing this study, the question arises: does the demand for professional education courses in the city of Itaporã-MS meet the market needs and/or the productive arrangements of the market? This problem forms the background of the study.

Talking about the importance of professional education for the formation of citizenship and development of a nation is not easy, but it is not new either. According to Adam Smith, a Scottish philosopher and economist of the 18th century, he understood education as an object of fixed capital, constituting in the competencies and capabilities of the elements of a collectivity that, when developed, perpetuate its benefits. To be a citizen is to have the right to life, liberty, property, equality before the law, that is, to have all civil rights. It is also to participate in the destiny of society and education is a basic means for the exercise of citizenship. However, it does not constitute citizenship, but rather an indispensable condition for de facto citizenship. Education is an act that aims at social coexistence, citizenship and political awareness.

(SAVIANI, 2000).

According to Thomas and Oliveira (2009):

The school cannot forget that it is part of a society, and what happens there must be observed, discussed, in order to prepare its students for a critical look and for indignation. For it is through indignation that people overcome indifference, passivity before their rights to be citizens.

Still, according to the same authors, “it is up to the school to continue (and sometimes begin) the education started in the families, therefore, forming for citizenship should be the main concern of the school”.

Souza, apud Rodrigues (1996, p.66) states that:

When the citizen discovers that he is the principle of what exists and can exist with his participation, democracy begins to emerge. Citizenship and democracy go hand in hand and do not exist separately. Citizenship is not individualism, but the affirmation of each in their relationship of solidarity with others. Citizenship and democracy are based on ethical principles and have infinity as their limit. There is no limit to solidarity, freedom, equality, participation and diversity. Democracy is an inexhaustible work.

In this way, it is understood that the role of education in the formation of citizenship is essential to allow individuals to consider the definition of various social relations, the function of the State is to be able to interfere in the reality in which the citizen lives by asserting his rights. Education is one of the fundamental authors in the process of building citizenship, but it needs a foundation of the State to perform this task. Therefore, the State has a significant role to play in the construction of citizenship and the realization of democracy.

The Federal Constitution of 1988, in its Article 205, states: “Education, everyone's right and duty of the State and the family, will be promoted and encouraged with the collaboration of society, aiming at the full development of the person, their preparation for the exercise of citizenship and their qualification for work”. Therefore, it is also the State's task to ensure that education can be provided on a broad scale, meeting the aspirations of significant parts of the community and combining quality with social inclusion.

The world trend points to an irreversible and increasingly widespread achievement: the phenomenon of market globalization resulting from the internationalization of the economy. In this modern scenario, Brazil, in order to expand and solidify its presence in international trade, has to adapt its production to the quality and productivity patterns in force in the world economy.

According to Alves and Vieira (1995): “(...)the modernization process takes place both through technological innovations, led by the areas of information and microelectronics, and through new organizational and managerial processes” and continues:

The pace of horizontal expansion of technological innovations from these sectors to other branches of industry and services has been intense. The forecast is that more and more companies will adopt modern production processes and, therefore, the professional qualification of the worker may constitute a critical node for the expansion of these processes. The data on the level of education of the workforce is not encouraging. According to the National Household Sample Survey (PNAD/90), 53% of the workforce, about 33 million workers, had up to five years of study;

according to international analyses, at least eight years of study are necessary to obtain the minimum knowledge that allows the effectiveness of specific training. (ALVES and VIEIRA, 1995).

According to the authors, “The country therefore has an enormous obstacle to overcome: that of qualifying, in time consistent with the needs, the workers to ensure them quality jobs and ensure the success of the process of productive modernization”. The challenge is to massively qualify workers with a methodology that breaks with the traditional concept of professional training and incorporates school training to enable the continuation of the educational process of the worker.

Quoting Alves and Vieira (1995):

It is in this context that the government promotes the expansion of the National Industrial Learning Service (SENAI) and the National Commercial Learning Service (SENAC) to provide the workforce with the required quantity and quality. At the first signs of exhaustion of the growth model, the discussion about the importance of education gains strength. The theory of human capital emerges, with the argument that investments in human resources avoid the underutilization of investments made in physical capital. At that time, the segmentation of Brazilian education into two distinct parts: formal education, in which the students had access to a basic set of knowledge that was wider and wider as they progressed in their studies; and education for work, almost exclusively of SENAI and SENAC, in which the student received a set of relevant information for the mastery of his or her trade, without an educational deepening that would give him or her the conditions to continue in the studies, or even to qualify in other domains.

The term professional education was introduced by the Law of Directives and Bases of Education – LDB (Law nº 9.394/96, cap. III, art.39): “Professional education, integrated to the different forms of education, work, science and technology, leads to the permanent development of skills for productive life”. According to Cordão (2006), the new focus given to professional education supposes the total overcoming of the traditional understanding of professional education as a simple instrument of a welfare policy, or even as a linear adjustment to the demands of the labor market. Thus, according to this author, professional education is considered an important strategy for citizens, in increasing numbers, to have effective access to the scientific and technological achievements of contemporary society. The creation of PLANFOR (Plano Nacional de Qualificação do Trabalhador – National Plan for Workers’ Qualification) in 1995 laid the foundations for achieving economic stability, seeking to raise labor productivity, including professional education in public labor policy. The PROEP (Programa de Expansão da Educação Profissional) had its initial milestone in 1997, with the objective of developing actions that integrate education and work, science and technology, aiming at the implementation of a new model of professional education, which would provide the expansion of vacancies, the diversity of offer and the definition of courses appropriate to the demands of the world of work (WITTACZIK, 2008; CIAVATTA, 2002).

In 2003, an expansion of the federal network of professional education was initiated. In 2005, the veto to the creation of new CEFETs was overthrown and a new model of professional and technological education institution, the Federal Institutes of Education, Science and Technology (IFTs), was created within the Ministry of Education through Law No. 11,892/2008. Law 11,892/08 integrated a set of normative

measures aimed at implementing the Education Development Plan (PDE) of the Lula administration, which had it as one of the most important educational components of the Growth Acceleration Plan (PAC) (WITTACZIK, 2008; CIAVATTA, 2002). The National Program for Youth Inclusion (PROJOVEM), implemented in 2005 by the General Secretariat of the Presidency of the Republic in partnership with the Ministry of Education, the Ministry of Labor and Employment, and the Ministry of Social Development and Fight Against Hunger, whose recipients are young people between the ages of 18 and 24, who finished the fourth grade, but did not finish the eighth grade of elementary school and have no formal labor ties. The Program for the Integration of Professional Education into High School in the Youth and Adult Education Mode (PROEJA), whose objective is the expansion of public spaces for professional education for adults and the contribution to the universalization of basic education, obliged the institutions of the federal network of technical and technological education to allocate, in 2006, the corresponding to 10% of the vacancies offered in 2005 for high school integrated to professional education for young people over 18 years old and adults who have attended only elementary school (WITTACZIK, 2008; CIAVATTA, 2002). The Brasil Profissionalizado program, dated 2007, integrates the PDE in the same way as other initiatives focused on professional education and comes to finance the expansion and equipment of state high school networks, adapting more state schools to expand the offer of integrated high school education to professional education. The program aims at transferring resources to the states in order to encourage them to resume offering free high school professional education in the state public education network (WITTACZIK, 2008; CIAVATTA, 2002).

As stated in Bill 3775/2008:

President Luiz Inácio Lula da Silva signed on July 16, 2008 the 3775/2008 Bill that creates 38 (thirty-eight) federal institutes of education, science and technology in the country. The subject followed for approval in the National Congress and on December 29, 2008 was sanctioned by the president. The institutes should have a strong insertion in the research and extension area, aiming at stimulating the development of technical and technological solutions and extending their benefits to the community. Half of the vacancies will be destined to the offer of technical courses of medium level, in special integrated curriculum courses. In higher education, the highlight is for the engineering technology courses and graduation courses in physical sciences, chemistry, mathematics and biology. Graduates of specific professional and technological education content will also be encouraged, such as the training of mechanics, electricity and computer science teachers. The federal institutes will have autonomy, within the limits of their territorial area, to create and extinguish courses, as well as to register diplomas of the courses they offer, upon authorization of their Superior Council. They will also exercise the role of accrediting and certifying institutions of professional skills. "Each federal institute is organized in a structure with several campuses, with an annual budget proposal identified for each campus and rectory, equating with federal universities.

And so the Federal Institute of Education, Science and Technology of Mato Grosso do Sul (IFMS) was created by Law No. 11,892 of December 29, 2008, when the Ministry of Education (MEC) restructured the Federal Network of Professional, Scientific and Technological Education. The process of implementing

IFMS began in 2007, with the sanction of Law No. 11,534 of October 25, 2007, which created federal technical and agro-technical schools. On that occasion, the Federal Technical School of Mato Grosso do Sul, with headquarters in Campo Grande, and the Federal Agro-technical School of Nova Andradina were established.

The following year, with the restructuring of the Federal Network, the IFMS was created with the planned installation of the Campo Grande and Nova Andradina campuses. On that occasion, MEC designated the Federal Technological University of Paraná (UTFPR) as the tutor of the implementation process for a period of two years. In 2009, with the new expansion project of the Federal Network, five other campuses were created in the municipalities of Aquidauana, Corumbá, Coxim, Ponta Porã and Três Lagoas.

The New Andradina Campus was the first to come into operation in 2010, through the publication of MEC Ordinance No. 170/2010. On February 1 of that year, in Brasília, 78 campuses of Federal Institutes were inaugurated, among them the first of IFMS. The first servers took office on the 8th of the same month.

The following year, MEC Ordinance No. 79 of 31 January 2011 authorized the operation of the other six campuses. The units began teaching activities in provisional locations with the offer of distance education courses, in partnership with the Federal Institute of Paraná (IFPR) and municipal governments.

As the works were being completed, students and servers began activities on the final campuses. In Aquidauana, classes at the new headquarters began on September 2, 2013. On the 30th of the same month, the Ponta Porã Campus began operating in the building built on a 25 hectare area donated by the city government. It would be the second unit with a vocation for education in the countryside, as well as Nova Andradina.

On April 28, 2014, activities began at the Coxim Campus. In Três Lagoas, the definitive headquarters began operating on May 12 of that year. In June, the Federal Government held the official inauguration of these four campuses, in Brasília. In 2014, three new units were created in the municipalities of Dourados, Jardim and Naviraí, whose headquarters are now being built. Initially, professional qualification and language courses were offered.

MEC Ordinance No. 378 of May 9, 2016 authorized the operation of the new campuses. On that date, Dourados and Jardim were officially inaugurated by the Presidency of the Republic, in Brasília. In 2016, the Dourados Campus started the school year at the definitive headquarters. On October 25, the Campus Jardim was handed over to the community. The Campus Campo Grande's definitive headquarters started operating in July 2017, and Corumbá's in the first semester of 2018. Currently, only the Naviraí Campus operates in temporary headquarters. In the ten municipalities, IFMS offers technical courses of medium level, undergraduate, graduate, and distance education, besides professional qualification.

Through the offer of Professional, Scientific and Technological Education, the insertion of IFMS has a strong presence in the main regions of the State of Mato Grosso do Sul, constituting, since its creation, a new scenario of possibilities for young people and adults in each locality, leading to relevant developments for the social, cultural and local productive arrangements.

The State of Mato Grosso do Sul consists of 79 municipalities with an estimated population of 2,449,024 inhabitants, of which the Dourados campus, in its area of coverage, is part: Caarapó, Deodápolis, Douradina, Dourados, Fátima do Sul, Glória de Dourados, Itaporã, Jateí, Maracaju, Rio Brillhante, Vicentina, making up a total population of 404,808 inhabitants according to data from IBGE (2010), containing low

demographic concentration in its territory, with approximately 84% of the state population living in the urban area.

The IFMS PDI provides for the contracting of partnerships with municipalities that are part of the Campus' area of scope to offer professional qualification education courses through distance education. The proposal for the implementation and realization of FIC's Initial and Continuing Education Courses in the Distance Education Mode (EaD) meets the need for humanistic-technical-scientific training for the consolidation of IFMS's social role through the provision of education with a view to building a network of knowledge that interweaves culture, work, science and technology in favor of a fairer, less unequal, more autonomous and solidary society. The implementation of the courses is in accordance with the proposal of the Law of Guidelines and Bases of National Education - LDB, No. 9,394, of December 20, 1996, which bases the educational practice linked to the world of work and social practice, as well as the consolidation and deepening of knowledge acquired in elementary school, basic preparation for work and citizenship, understanding of the scientific-technological foundations of productive processes, relating theory to practice. Considering Decree No. 5,154 of July 23, 2004, the course is organized according to the socio-occupational and technological structure of the training area, articulating efforts in the areas of education, work and employment, and science and technology so that the entrant can act effectively in the world of work.

Likewise, we have a large contingent of workers who have not had the opportunity to qualify at these levels and, consequently, have not occupied vacancies in the labor market. Therefore, the offer of Initial and Continuing Training or Professional Qualification courses FIC represents the possibility of social inclusion, training and training of human resources. This way, the Vendor course is proposed, aiming to train, qualify and improve sales techniques, seeking to improve the technical capacity of people interested in this area of knowledge.

Operations in both industry and the service sector have prioritized the use of computer-based systems. Therefore, basic knowledge in computer operation is essential for a better insertion in the world of work. The constant evolution of information technologies makes clear the importance of mastering the techniques of computer use, from the most basic to the most advanced operations.

In the case studied here, this partnership is being practiced with the city of Itaporã, about 20 km away from the city of Dourados, with some industries installed, being them in the food business, extraction of natural resources and cereals and also small and medium sized commerce from various areas.

The IFMS Distance Education (EaD) is considered a non-presential meeting between subjects through Information and Communication Technologies (ICTs). Such subjects dialogue and build relationships, knowledge, practices and existential situations, in order to carry out interventions in the reality in which they are inserted. The activities involve the use of a virtual teaching and learning environment (AVEA) through the Moodle Platform, in which distance activities are developed. Once a week, students meet in person at the presence of their tutor to clarify doubts and develop activities proposed by the teachers of the curricular units.



## **2. Methodology**

In order to carry out the transversal diagnosis of the panorama of professional education in the municipality of Itaporã – Mato Grosso do Sul, the guided interview technique was implemented in loco with the coordinating agents of the action designated by the municipal administration. A previous block of questions was pre-defined, blinded to the interviewee, in order to obtain a greater volume of technical information regarding: the number of courses, number of vacancies, historical line of qualification and logistical issues involved in the regency of the courses.

In a second moment, the interview was programmed for the technique of free reporting allowing the asset of information that the interviewee judged necessary for a better understanding of the topic; moreover, it contributed to the survey data collected from the business sense of the municipality in question.

Everyone involved was aware of their free and voluntary collaboration. During the entire collection stage the information was kept in a free association chart which, later revised, gave basis to the narrative of the results that follows.

## **3. Results and Discussion**

In order to collect data for the study, the technique of on-site guided interview was implemented with the action coordinating agents designated by the municipal administration. All those involved were aware of their free and voluntary collaboration. During the entire collection stage, the information was kept in a free association chart, which was later reviewed and the interview lasted about an hour and a half. On the day chosen to carry out the data collection, I was received by GEDU employee Gabriel Oliveira Vilharga, who also performs the role of face-to-face tutor for the courses offered in this partnership, he collaborated with the interview and the data collected were sufficient to prepare this case study.

According to the data collection, the professional training courses offered in the city of Itaporã-MS are those of “Computer Operators” and “Salesman” at the Municipal School Teacher Sônia Teixeira Paiva. In 2017 the two courses were offered (2 classes of the Computer Operator course and 4 classes of the Computer Operator course), with a good achievement with 62 certified students in the Computer Operator course and 41 students in the Salesman course, with distance mediation by the Education Coordinator/IFMS Lígia Karina Meneghetti and the face-to-face tutor Gabriel Oliveira Vilharga/Employee of GEDU of Itaporã and in this year of 2020 only the Salesman course will be offered.

It was found that the capitation of these students is made through ads published in the GEDU Blog, in social networks, in visits made to schools and posters in the basic health care posts, in the operator and seller course the interested party must have concluded the elementary school, the perspectives are that this partnership lasts for several years and the expectation is that other courses are also offered to meet the labor market of the municipality.

During the study, it was noticed some obstacles that did not corroborate the demand of the municipality's population to enroll in the courses; an example of this is that in the disclosure stage it was identified that when the course is announced by IFMS, GEDU does not have enough time to contact the possible students. This aspect is aggravated when we take into account that, in addition to the districts, the municipality also has a large rural area, which should certainly be advertised in loco, since internet access is slow and



precarious.

It was also noted that the fact that the course is offered only at night, ends up discouraging the participation of some potential students who, despite showing interest, need to pay attention to their labor routines, especially at the time of the harvest. Another fact that was noticed is the content approached, mainly the operator course, some students thought that some topics will not be useful in their professional life, while others have great difficulty with the student portal.

During the study it was found that the courses offered contemplate the guiding hypothesis since they meet the needs of the industrial and marketing arrangements of the municipality, on the other hand, it was found that it was casual this service, since no mapping of the employment demand of the municipality was made and, nevertheless, also a post-course evaluation in order to verify whether these companies are absorbing this skilled labor.

#### **4. Final considerations**

The results obtained allow us to conclude that a greater concern is necessary, on the part of those involved in this partnership, to create a database of course graduates in order to establish a periodic sense capable of identifying professional life after the course: which ones have achieved a placement in the job market, which ones have obtained a level increase or even returned to take new courses. It is also necessary to study with local industries and commerce in order to draw a profile of the demand for qualified labor in order to detect which training is important at the moment to fill job vacancies and meet their needs, since they are different industries and businesses.

#### **5. Competing Interests**

The authors declare no competing interests.

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# **What We Know About the Genetic Determinants of Human Homosexuality? A Short Review Communication**

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## **Abstract**

*“Homosexuality”, “sexual orientation disorder”, “egodistonic homosexuality”, “unspecified sexual disorder”, “sexual maturity disorder” and “sexual relationship disorder”. Since 1948, these have been, throughout the history of the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Statistical Classification of Diseases and Related Health Problems (ICD), the terms used by the scientific community to categorize the homoaffective spectrum until in 2017, in the face of strong social and academic demand, their complete disengagement from any terminology that categorizes them as physical and/or mental illness. On the other hand, some areas of science have contributed substantially to a better understanding of this subject, such as genetics and epigenetics. Today, although the scientific community still offers some points of resistance, especially in more conservative countries, it is a consensus that since the implementation of the genome project there has been a considerable methodological expansion that has opened new possibilities of studies that have allowed this advance.*

**Keywords:** Homosexuality; Human Homosexuality; Genetics; LGBTQIA+ Community.

## **1. Introduction**

“Homosexuality”, “sexual orientation disorder”, “egodistonic homosexuality”, “unspecified sexual disorder”, “sexual maturity disorder” and “sexual relationship disorder”. Since 1948, these have been, throughout the history of the Diagnostic and Statistical Manual of Mental Disorders (DSM) and the International Statistical Classification of Diseases and Related Health Problems (ICD), the terms used by the scientific community to categorize the homoaffective spectrum until in 2017, in the face of strong social and academic demand, their complete disengagement from any terminology that categorizes them as physical and/or mental illness. Despite this conceptual advance, the counterproductive effects of the pathological association of homosexuality are still evident. In Brazil, for example, the current historical and political moment has given rise to debate on the subject, above all because of the remarkable rise of movements for the restoration of the family, morals, ethics, and “good manners” – a fact that highlights the still present and erroneous pathological notion of homosexuality in various social spheres. On the other hand, some areas of science have contributed substantially to a better understanding of this subject, such

as genetics and epigenetics. Today, although the scientific community still offers some points of resistance, especially in more conservative countries, it is a consensus that since the implementation of the genome project there has been a considerable methodological expansion that has opened new possibilities of studies that have allowed this advance.

## **2. Methodology and systematic results**

The systematic review took place in April 2020 in the PubMed network and resulted in 1470 references; the search was composed from the term “homosexuality” necessarily described in the title of each study. Considering the restricted range of the subject, there was no implementation of limits for the year and for the language of publication of the articles. The screening process took place by sequentially reading the title, abstract and full text, respectively, which resulted in 15 selected scientific articles. Although preliminary and with some caveats regarding the scientific quality of the selected studies – once methodological biases were identified in nine of them – it was possible to collect a total of 14 findings regarding the genetic determinants of human homosexuality according to the results of the primary randomized clinical trials and other systematic reviews that made up the final selection body.

## **3. Main genetic findings extracted**

a) In men, sexual orientation is correlated with the number of siblings, so that for each older heterosexual brother born, the chances of the next child being homosexual increase by approximately 33%; b) this correlation with the fraternal birth order is true regardless of the number of women born among the siblings; c) the occurrence of a homosexual child, however, does not alter the chances of the next child also being homosexual; d) after each pregnancy of a male fetus the woman presents, in comparison with the previous pregnancy, a significant increase of H-Y antibodies, with the caveat here that these antibodies are inoperative and have no practical effects described so far; e) the incidence rates of homosexuals in the human species are mathematically consistent enough to exclude the hypothesis that it would be the result of successive random mutations in the DNA; f) contrary, therefore, to the Darwinian logic, the evidence from population studies allows us to suggest that the process of natural selection is occurring in favor of the maintenance of homosexuality in humans, taking into account the time of existence of the species *Homo sapiens*; g) the statistical interpretation of the epidemiological and epigenetic studies already carried out allows us to suggest that, although gene multiplicity may be strongly involved, the occurrence of homosexuality in humans may be being understood as advantageous from the evolutionary point of view of the species; h) it is virtually impossible so far, however, to reasonably assume the reasons why this occurs; i) reproductive disorders such as infertility, premature ejaculation and erectile dysfunction are less prevalent in homosexual men than in heterosexual men. However, other aspects such as delayed ejaculation or an-ejaculation are more frequent; j) when analyzing frequency distribution, family grouping, ethnic asymmetry, and sibling agreement, population patterns observed empirically point strongly to the genetic inheritability of homosexuality. However, environmental factors such as the social and educational scope of the individual play a relevant role in modulating the gene expression of the phenotype of homosexual behavior; k) they also point out that these environmental factors statistically have a greater influence on the occurrence of female than male homosexuality; l) however, in both genders, in the absence of the genetic factor, the isolated occurrence of these environmental factors has little or no influence in determining

the individual's sexual orientation; m) the GWAS (Genome Wide Association Study) type studies indicate that of all the discordant genes identified so far, two are statistically more expressed in the homosexual population: the SLITRK and TSHR genes that respond, respectively, to neural activity and to thyroid regulation; and, n) all population studies published so far show that the agreement on sexual orientation among univiteline twin siblings is significantly higher (from 48 to 76%) than in heterozygotic siblings.

#### **4. Final considerations**

The genetic influence in the determination of sexual orientation is already widely consolidated in the field of medical sciences, however new studies are necessary given the high methodological variability between them. Most of the genetic researches carried out so far deal exclusively with male homosexuality, so it is essential to broaden the focus of these studies in order to increase, also in the scope of scientific publications, the representativeness of the other segments of this population. Nevertheless, it is a consensus that most of the homophobic argument is based on the assumption, at the common sense level, that sexual orientation and gender identity are factors that can be chosen and that, consequently, in this semiotics, they would be reversible. It is in this sense that the dissemination of this knowledge beyond the academic world is so important and can, within the limits of medical ethics, contribute to the debate and to the continuity of the struggle for a more egalitarian and less discriminatory society as far as the LGBTQI+ community is concerned.

#### **5. Competing Interests**

The authors declare no competing interests.

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## **Evaluation of the effectiveness of three therapeutic protocols used in the treatment of visceral canine leishmaniosis**

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### **Abstract**

*Leishmaniasis is a tropical and subtropical disease caused by an intracellular protozoan transmitted by a bite from a vector, mainly from the genera Phlebotomus and Lutzomyia, and affects humans and other mammals, especially dogs. The main objective in controlling canine visceral leishmaniasis is to reduce the number of human cases by reducing its prevalence in dogs. In Brazil, glucantime antimoniate and Amphotericin B, utilized for treating the disease in humans, are prohibited so that only miltefosine, which is not employed for treatment of humans, is permitted for use in dogs. This work aimed to evaluate the efficacy of three different therapeutic protocols employed in the treatment of dogs naturally infected with visceral leishmaniasis. Fifty-six (56) dogs, of both sexes, were treated and evaluated utilizing three treatment protocols. The following protocols were utilized: association of several drugs; miltefosine associated with allopurinol; and immunotherapy with anti- Leishmania vaccine associated with Allopurinol. Immunotherapy was the most efficient protocol, followed by an association of drugs and miltefosine. The use of these protocols diminishes the constant relapses of the disease. Associations of therapeutic protocols produced clinical improvement of patients even with presentation of subsequent negative serology. However, the study did not include aspects related to hemoparasitoses, thus a further study is required.*

**Keywords:** Canine leishmaniasis; Chemotherapy; Immunotherapy

## 1. Introduction

Leishmaniasis is a tropical and subtropical disease caused by an intracellular protozoan transmitted by a bite of a vector, principally of the genera *Phlebotomus* and *Lutzomyia*. It is present in approximately 89 countries distributed among the continents of Europe, Africa, Asia and South America. It is one of the seven most important tropical diseases, representing a serious global public health problem. It presents a wide spectrum of clinical manifestations (cutaneous, mucocutaneous, cutaneous-diffuse and visceral forms) with a potentially fatal result (Torres-Guerreiro et al. 2017). According to the World Health Organization (WHO), the visceral form is considered the most important and severe, infecting from 200,000 to 400,000 persons per year throughout the world, with a mortality rate between 10% and 20% (Savoia 2015).

In addition to humans, the visceral form also affects several mammalian species, including dogs, considered the main peri-domiciliary reservoir of the parasite in endemic areas. The main objective of controlling canine visceral leishmaniasis is to reduce the number of cases of the disease in humans by reducing its prevalence in dogs. Among the control methods utilized are: diagnosis and euthanasia of sick animals, diagnosis and treatment of symptomatic or asymptomatic infected dogs, vector control (use of repellents on the animal and in the environment), use of vaccines and canine population control. In recent years, studies have not proven the efficacy of elimination of infected animals and have shown that in endemic regions that have employed this method there were no reductions in the number of human cases. A large portion of the population, especially in developed countries, consider the practice of this method ethically unacceptable (Solano-Gallego et al. 2011, Vulpiani et al. 2011, Ribeiro et al. 2013).

The objectives of canine leishmaniasis treatment are to reduce the parasitic load in the animal in order to diminish its transmission capacity, to promote a clinical cure, to restore effective immune responses and to stabilize the clinical improvement to avoid relapses. Diverse drugs and protocols have been used for treatment of infected dogs (Oliva et al. 2010, Vulpiani et al. 2011).

The main drugs utilized for the treatment of leishmaniasis in humans are pentavalent antimonials (sodium stibogluconate and meglumine antimoniate), Amphotericin B, miltefosine and pentamidine (Croft & Coombs 2003). In Europe, drugs such as meglumine antimoniate, miltefosine and Amphotericin B are commonly used in the treatment of canine leishmaniasis (Solano-Gallego et al. 2009, 2011). In Brazil, glucantime antimoniate and Amphotericin B, utilized for treating the disease in humans, are prohibited (Ribeiro et al. 2013), whereas only miltefosine is permitted for use in dogs. Given this context, there is an ongoing search for other drugs or alternative therapeutic protocols for treating canine leishmaniasis.

This work aimed to evaluate the efficacy of three different therapeutic protocols (association of several drugs; miltefosine associated with Allopurinol; and immunotherapy with anti-Leishmania vaccine associated with Allopurinol) utilized in the treatment of dogs with visceral leishmaniasis, naturally infected.

## 2. Methodology

### 2.1 Animals

The study was conducted in the city of Campo Grande-MS, Brazil, a region endemic for canine

visceral leishmaniasis.

The animals were attended in a specialized veterinary clinic, where the diagnosis, treatment and accompaniment were carried out between April of 2007 and December of 2019. Data collection was performed in the period from April 24, 2017, to January 11, 2020.

Fifty-six (56) dogs were evaluated (26 males and 30 females), aged between one and 15 years; diverse breeds and individuals of undefined breed were included, naturally infected by *Leishmania infantum*.

The diagnosis was based on observation of clinical alterations associated with leishmaniasis, positive serology with detection of anti-*Leishmania* antibodies by the tests Enzyme-Linked Immunosorbent Assay - ELISA and Indirect Fluorescent Antibody Test - IFAT (Hermes Pardini Laboratory and Tecs Laboratory), hematological, renal and hepatic laboratory evaluation, and observation of amastigote forms in aspirative puncture cytology of the lymph nodes and / or bone marrow. The first protocol for the first treatment was decided by evaluating the animal clinically, and also by complementary exams. A second protocol was performed if the animal was serologically positive after the end of the treatment, with any titer being considered positive and negative when the serology presented non-reactivity. The protocol instituted at that point should differ from the prior one. The same animal may continue to be reactive and be administered up to a third different treatment protocol.

The time between the application of the protocols and the result of the final diagnosis, according to serology, varied from one case to another. It should be emphasized that until 2019, the majority of the animals were alive, clinically monitored by semiannual exams and submitted to new protocols depending on post-treatment monitoring exams.

All the animals' owners that were included in this retrospective study signed terms of duly informed consent for participation.

## **2.2 Clinical and laboratory evaluation**

First, the animals were submitted to a clinical exam for evaluation of the presence or absence of clinical signs associated with visceral leishmaniasis. Next, blood samples were collected for the serological exam (IFAT and ELISA), blood counts, biochemical exams (dosing of alanine aminotransferase-ALT, alkaline phosphatase-FA, urea, creatinine) and aspiration of lymph nodes for direct cytological examination. After confirmation of the disease, the treatment was initiated.

## **2.3 Therapeutic protocols**

Three therapeutic protocols were utilized:

T1 – Miltefosine (Milteforan®, Virbac, Carros, France) 2mg/kg, orally once per day for 30 days associated with allopurinol (10mg/kg orally, twice per day, continuous use).

T2 - Association of the different drugs.

Various drugs were utilized in an associated form, composing 2 formulas, under the form of a manipulated medication. The treatment time of each formula comprised 60 days, totaling a cycle of 4 months of treatment. The composition of each formula depended on each clinical case in particular.

The principal substances utilized were:

- allopurinol, daily dose 20mg/kg, orally, divided into two doses.
- ketoconazole 14-20mg/kg, orally, every 12 hours, between meals (acidic stomach)
- metronidazol 20-30mg/kg, orally, every 12 hours.
- L-arginine aspartate 10-20mg/kg, orally, every 12 hours.
- zinc sulfate 10-15mg/kg, orally, every 12 hours.
- doxycycline hydrochloride, 10-20mg/kg, orally, every 12 hours.
- domperidone 0.5-1mg/kg, orally, every 12 hours.

The formulas were elaborated by a veterinary physician, after clinical and laboratory evaluation, being adjusted according to animal body weight and the necessary components.

In addition to the formula, prednisone was also prescribed at 0.1mg/kg, orally, every 12 hours.

Example of the master formula (in capsule) for one 10kg dog:

Allopurinol 100mg

Cetoconal 100mg

Metronidazol 200mg

Cloridrato de doxiciclina 200mg

L-arginine aspartate 100mg

Zinc sulfate 100mg

Domperidone 5mg

T3 - Immunotherapy with the vaccines Leishmune<sup>®</sup> (Zoetis, New Jersey, USA) (Borja-Cabrera et al. 2004) and Leish-Tec<sup>®</sup> (Ceva Santé Animale, Paris, France), with application of two doses of vaccine every 21 days, totaling three applications associated with allopurinol 10 mg/kg orally, two times per day, continuous use.

At the end of each treatment, new clinical and laboratory exams were performed to verify the efficacy of the protocol utilized. If the disease was not controlled, the animal was submitted to a new cycle of treatment employing the same protocol or a different one. Thus, the protocols were classified in the following manner: T1- animals that were submitted only to treatment with miltefosine and Allopurinol; T2 – treatment only with an association of drugs; T3 – treatment only with immunotherapy and Allopurinol. The order and time interval in which the treatments were carried out in the associated protocols varied on a case-by-case basis. Some of the animals were counted more than once since they had been submitted to more than one treatment. In the post-treatment evaluation, if the animal presented persistence of serological positivity, another treatment protocol was instituted according to the clinical and exam results.

### **2.3 Post-treatment evaluation**

Immediately after the end of treatment, a new clinical evaluation and collection of blood samples were carried out for the serological exam (IFAT and ELISA), blood count, biochemical exams (dosage of alanine aminotransferase-ALT, alkaline phosphatase-FA, urea, creatinine) and lymph-node aspiration for direct cytological examination. The treatment efficacy was evaluated through the presence or absence of clinical signs, negative serology, hematological status (remission of anemia, leukopenia, thrombocytopenia) and

biochemical (kidney and liver function). Subsequently, these exams were repeated every 4 months in the first year; in the second year every 6 months and afterwards one time per year to control the infection and monitor the animal.

### 3. Results

#### 3.1 Clinical signs

All the animals from the study presented one or more clinical symptoms associated with canine visceral leishmaniasis. The main alterations observed were: weight loss, dermatopathies (ulcerated skin lesions, crusts, alopecia, seborrhea, etc.), ocular injuries, epistaxis, pallid mucosae, lymphadenomegaly, hepatomegaly, splenomegaly and onychogryphosis. In 49 of the 56 animals two dermatopathies, namely crusts and seborrhea, were observed. After the treatments, independent of the protocol utilized, there was total or partial remission of the clinical signs, including the dermatopathies (Table 1).

Table 1. Evaluation of the presence of seborrhea and crust lesions before and after treatment according to clinical observation

Clinical Observation of Lesion	Crusts		Seborrhea	
	Before Treatment	After Treatment	Before Treatment	After Treatment
Absence	36 (73%)	48 (98%)	33 (67%)	42 (86%)
Presence	13 (27%)	1 (2%)	16 (33%)	7 (14%)
TOTAL	49 (100%)	49 (100%)	49 (100%)	49 (100%)

As shown in Table 1, 13 animals presented lesions and crusts, whereas after the treatment there was improvement in 93%, that is, only one animal continued to present lesions. Seborrhea lesion was presented by 14 animals, but after the treatment, only 7 animals continued presenting the symptom, characterizing an improvement in 50%. The appearance of new lesions was not detected after the treatments.

#### 3.2 Cytology

Table 2. Comparison of results of the exams conducted before and after conducting treatment protocols

Animal Identification	Protocol	Serology		Cytology	
		Before	After	Before	After
3	T1+T2+T3	POS	POS	-	POS
4	T1+T2	POS	NEG	NEG	-
5	T1	POS	POS	POS	-
11	T3	POS	POS	POS	-
15	T1+T2	POS	POS	-	POS
16	T1+T2+T3	POS	POS	NEG	-
22	T1	POS	POS	-	NEG
29	T3	POS	NEG	POS	-



30	T2	POS	POS	-	NEG
33	T11+T2	POS	POS	-	POS
36	T3	POS	NEG	POS	NEG
52	T3	POS	NEG	POS	NEG
53	T2	POS	POS	-	NEG

Cytology was carried out in 13 animals, including five animals only before the treatment, six only afterwards and two both before and after the treatment. As to the two animals tested before and after the treatment, both presented positive results before and negative results after undergoing the protocol.

Of the five animals on which cytology was performed only before the protocol, only two obtained a negative result.

Five of the six animals subjected to cytology only after the protocol obtained a negative result; of these, three still presented a positive result in serology.

It should be emphasized that when the cytology exam has a positive result, it is considered confirmation of the disease, but in the case of a negative result other exams must be performed to obtain a conclusive diagnosis.

### 3.3 Serology

Before the treatment, the animals were considered serologically positive when antibodies were detected in ELISA with an optical density above the cutoff and presented titer starting from 1:40 in IFAT. All the animals presented positive serology in ELISA and IFAT.

Table 3. Comparison of serological results after conducting post-treatment exams

PROTOCOL	POS	NEG	TOTAL	% NEG
T1	8	3	11	27%
T2	12	5	17	29%
T3	16	8	24	33%
T1+T2	6	1	7	14%
T1+T3	3	0	3	0%
T2+T3	5	3	8	38%
T1+T2+T3	5	1	6	17%
<b>TOTAL</b>	<b>55</b>	<b>21</b>	<b>76</b>	

Table 3 shows the percentage of seronegative and seropositive animals after the treatments. Among the animals submitted to only one treatment protocol, T3 (immunotherapy with vaccines) was the most efficacious, followed by T2 (association of drugs) and T1 (miltefosine). The animals that presented relapses were submitted to new treatment cycles utilizing protocols different in each cycle, with the best response being observed in the animals treated with an association of drugs and immunotherapy, protocols T2+T3 with a negative percentage of 38%, as displayed in Table 3.

To evaluate the treatment efficacy, the animals were expected to present negative serology in the

ELISA and IFAT tests after the treatments.

### 3.4 Hematology

For the animals submitted to different protocols, the median values of blood counts were found near or within the normal range of values. The seropositive animals were those that presented a higher percentage of hematimetry outside the normality limit (60%) while 43% of negative animals were outside of normality.

Table 4. Number and percentage of animals with blood count outside normal limits after treatment according to diagnosis after the last serology performed

Final Diag .	Protocol	Total Number of Animals	Erythrocytes	Hgb	Hct	Platelets	Leuk	Lymph	Seg	Eosin
POS	T1	7	43%	71%	57%	86%	29%	43%	29%	29%
POS	T2	13	69%	77%	69%	54%	23%	46%	23%	15%
POS	T3	13	46%	54%	46%	62%	23%	38%	15%	15%
POS	T1+T2	6	50%	67%	67%	67%	50%	67%	50%	0%
POS	T1+T3	2	50%	50%	100 %	100%	50%	50%	100%	50%
POS	T2+T3	3	33%	33%	0%	33%	0%	33%	33%	0%
POS	T1+T2+T 3	5	40%	80%	40%	60%	40%	60%	20%	0%
POS		<b>49</b>	<b>51%</b>	<b>65%</b>	<b>55%</b>	<b>63%</b>	<b>29%</b>	<b>47%</b>	<b>29%</b>	<b>14%</b>
NEG	T1	2	50%	50%	100 %	0%	50%	0%	0%	0%
NEG	T2	3	33%	67%	67%	67%	67%	33%	67%	0%
NEG	T3	7	14%	14%	14%	57%	29%	43%	29%	14%
NEG	T1+T2	1	0%	0%	0%	0%	100 %	100%	0%	.
NEG	T1+T3	0	.	.	.	.	.	.	.	.
NEG	T2+T3	3	0%	0%	0%	33%	0%	0%	0%	67%
NEG	T1+T2+T 3	0	.	.	.	.	.	.	.	.
NEG		<b>16</b>	<b>19%</b>	<b>25%</b>	<b>31%</b>	<b>44%</b>	<b>31%</b>	<b>25%</b>	<b>25%</b>	<b>19%</b>

As shown in Table 4, 100% of the seropositive animals submitted to the protocol T1+T3 presented a platelet score outside of normality, while in the animals submitted to the protocol T1+T2 this value was 67%. Of the seronegative animals submitted to the protocols T3 and T2+T3, 67% presented platelet count outside of normality and of the seronegative total, 57% presented an abnormal platelet count.

### 3.5 Biochemical exams

The median values of FA, ALT, urea and creatinine, with the different protocols demonstrated that the majority of animals with final result serologically positive or serologically negative remained within normality, as expressed by reference values, as displayed in Table 5.

Table 5. Number of animals that presented biochemical values outside normal limits after treatment, according to the diagnosis after the last serology performed

FINAL DIAG.	PROTOCOL	TOTAL NUMBER OF ANIMALS	FA	ALT	UREA	CREATININE
POS	T1	6	0%	33%	17%	17%
POS	T2	11	27%	9%	0%	0%
POS	T3	10	40%	0%	20%	30%
POS	T1+T2	5	60%	40%	20%	40%
POS	T1+T3	4	50%	50%	0%	0%
POS	T2+T3	3	0%	0%	33%	0%
POS	T1+T2+T3	5	20%	0%	60%	40%
POS		<b>44</b>	<b>30%</b>	<b>16%</b>	<b>18%</b>	<b>18%</b>
NEG	T1	3	33%	0%	67%	0%
NEG	T2	4	0%	50%	0%	0%
NEG	T3	8	13%	25%	50%	13%
NEG	T1+T2	1	0%	0%	100%	100%
NEG	T1+T3	3	33%	33%	67%	33%
NEG	T2+T3	0	.	.	.	.
NEG	T1+T2+T3	19	<b>16%</b>	<b>26%</b>	<b>47%</b>	<b>16%</b>
NEG		<b>3</b>	0%	33%	17%	17%

It should be emphasized that two animals, despite final results with negative serology, presented urea levels above the reference values, one of which showed at the beginning of treatment urea at 143mg/dL with protocol T1, and the other one during the treatments T1+T2+T3. In addition to the three protocols, these two animals were treated with renal diet and homeopathy and are clinically well through the present moment.

## 4. Discussion

It was observed that the different protocols did not interfere in relation to dermatopathies, given that there were no manifestations of lesions after the treatments and that all were equally effective at reducing skin lesions. The more severe the disease stage the more severe the dermatopathies (Solano-Gallego 2011).

Cytology revealed that the animals serologically positive after treatment may present negative cytology. In this manner, cytology is an exam in which a positive result indicates 100% confirmation of

leishmaniasis, but in the case of a negative result requires other exams for diagnosis.

Since it was a retrospective study and not a controlled experiment, there was no exact order in the choice of protocols of treatments. We found that, among the individual treatments, the most effective was immunotherapy with vaccines followed by an association of drugs. The absence of evolution of the disease after the use of two vaccine doses may indicate an immunomodulatory protective response against progression of the infection, provided by immunotherapeutic treatment with antigen A<sub>2</sub> associated with one milligram of saponin, which induces a Th1 response (Ribeiro et al. 2014). The immunotherapy associated with allopurinol promoted a reduction of clinical signs while some animals remained serologically negative in post-treatment control exams. The owners were instructed to use collars and repellent continuously since they are in endemic areas.

When the protocols T2+T3 were associated, independent of the order, the greatest number of serologically negative animals was obtained. As to the use of the formulas, the owner was oriented to administer the medication between meals to optimize the effect of ketoconazole against gastric acidity. Few cases of emesis were observed after the administration of the formulas, being well tolerated. Utilization of the drugs presents efficacy due to the different actions of the medications utilized in the formula. Allopurinol when administered orally acts on the enzyme xanthine oxidase, and inhibits metabolism of *Leishmania* (Reguera et al. 2016). Orally administered ketoconazole is leishmanistatic (Noli & Auxilia 2005, Favrot & Saridomichelakis 2010). Metronidazole administered orally is a weak leishmanistatic with few side effects and provides a satisfactory synergistic effect when given concomitantly with ketoconazole (Noli & Auxilia 2005, Favrot & Saridomichelakis 2010). L-arginine aspartate is an immunostimulant amino acid (Durante et al. 2007). Zinc sulfate has an immunostimulant effect (Afshari et al. 2016). Domperidone, utilized to avoid the nausea or vomiting induced by the medications taken, elevates the Th1 immune response, inhibits the Th2 response, and stimulates a neutrophilic response with memory effect of up to one month after suspension of the medication (Reguera et al. 2016). Prednisone was utilized in order to act as an immunomodulator, controlling the deleterious autoimmune effects of the disease (Afshari et al. 2016).

After 30 days of formula administration, it was possible to observe a considerable reduction in the clinical signs, whereas at the end of the second formula, at about 120 days after initiating the treatment, there was complete diminution of the clinical signs. With the use of different medications, the majority of these animals presented negative serology after four months of treatment. For the animals that remained serologically positive, but with low titers of antibodies, the greatest number of serologically negative animals post-treatment was obtained by the chosen protocol of immunotherapy with vaccines.

The association of miltefosine with allopurinol was the treatment that presented more relapses of the disease, given that miltefosine only reduces the replication of *Leishmania* and does not remove the parasite from the lymph nodes (Laura Manna et al. 2015).

After accompaniment with annual negative serology, it is believed that these animals presented a clinical cure.

Before initiating any of the protocols, the exams performed included blood count, biochemical tests and cytology. Two of the animals showed very high urea levels, but were clinically well, without apparent symptoms. Nevertheless, treatment was chosen. The two animals continue to be monitored, serologically negative, but still showing kidney alteration, and are being treated adequately. It is believed that this kidney

alteration is a probable sequela of the disease.

It was observed that even the animals serologically negative after treatment presented anemia, in some cases severe, requiring blood transfusion; in some cases, associated diseases such as *Erlichia* sp. and *Babesia* sp. were observed concomitantly with leishmaniasis, which hampered the treatment and accounted for the non-regenerative anemia. In general, the alterations in the initial diagnostic blood count were only mild anemia and slight reduction of platelets, without clinical importance.

## 5. Conclusion

Leishmaniasis is a disease that is difficult to treat, presents constant relapses and can be associated with other diseases such as hemoparasitoses. However, associations of therapeutic protocols produced clinical improvement of patients even with presentation of subsequent negative serology, a clinical picture that if maintained would require lifelong monitoring. It is also noteworthy that this study evaluated only the aspects related to the disease leishmaniasis, and did not include those related to hemoparasitoses, thus requiring a further study.

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# **The Perceived Use of Assessment by Beginning and Experienced SHS Mathematics Teachers in Two Districts in the Central Region of Ghana**

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## **ABSTRACT**

*The role of assessment in the teaching and learning of Mathematics cannot be under estimated. Therefore, efficacious teaching and learning of Mathematics must be driven by effective use of assessment. This study therefore sought to investigate the Use of assessment (practices) of Beginning and Experienced SHS Mathematics teachers in two selected districts in the central region of Ghana. In this study Assessment Practices means what SHS teachers use assessment to do in the teaching and learning of Mathematics under the auspices of a school. A sample of 160 SHS Mathematics teachers were used in this study. These were made up of 92 Beginning and 68 Experienced SHS Mathematics teachers. The instrument used in this study was a questionnaire. The questionnaire was administered to the 92 Beginning and 68 Experienced SHS Mathematics teachers in the two districts in the Central Region of Ghana. The design used in this study was cross-sectional survey. Data collected from the respondents were analysed using frequencies, percentages, means and standard deviations. Independent sample t-test was used in test whether there exists a significant difference in the assessment practices of the Beginning and Experienced SHS Mathematics teachers. It was found out that majority (87 out of 92) of the Beginning Senior High School Mathematics teachers do not either frequently or always integrate assessment in the teaching and learning of Mathematics. It was also found out that majority (60 out of 68) of the Experienced Senior High School Mathematics teachers also do not either frequently or always integrate assessment in the teaching and learning of Mathematics. They rather see classroom assessment as an additional activity which mainly comes at the end of the teaching learning process. The study also revealed a significant difference in the assessment practices of Beginning SHS Mathematics teachers and that the Experienced SHS Mathematics teachers in the two districts. Based on the findings, it was recommended among other things that In-service training should be organised for both the Experienced SHS Mathematics teachers and the Beginning SHS Mathematics teachers to help them bridge the gap that exist between their practices.*

**Keywords:** Classroom Assessment Practices; Beginning SHS Mathematics Teachers; Experienced SHS Mathematics Teachers.

## Introduction

It is the most cry of teachers, students, parents and school administrators that Senior High School students are assessed before, during or after a teaching section to enhance students understanding of Mathematical concepts and improve teacher's mode of teaching. The point is that assessment must form part in the creation of an effective learning process. However, a learning environment that is dominated by assessment procedures can detract the learning environment but we have found that if the students are able to see the value of the learning process, and that assessment is part of the learning and not an end in itself, then they can buy into the process and actually use it to gain better understanding of what ever concept that they are learning while benefiting from the learning environment which they help to create through their self-monitoring and peer-assessment activities( William, 2010). This idea has been demonstrated by William in identifying the processes of peer tutoring, co-operative learning, reciprocal teaching through predicting answers, questioning, clarifying, summarizing and collaborative reasoning ((Black & William, 2009). All of these processes when used in a classroom will empower the learners as they are placed at the center of the learning process; echoing Smith's question: What do you do in the classroom? If assessment activities are part of the doing of Mathematics, then they become a central part of the learning process which will elicit understanding of concepts.

Literature points to the fact that when thinking about the role of assessment in teachers' judgments, it is important to distinguish between externally mandated tests and various kinds of classroom assessment practices which are mainly under the direct control of the teacher (Shepard, 2006; Etsey, 2003; Stiggins & Chappuis, 2005). They added that external assessments are usually standardized, on demand tests that rely mostly on some kind of multiple-choice or short constructed response questions types. All students are assessed on the same few subjects and topics sampled for inclusion in each assessment, and all scores are reported and summarized in the same manner, typically in a norm or criterion referenced metric. Judgments of students' performance that is based solely or mainly on performance on standardized tests would likely be similar across teachers. In contrast, classroom assessment encompasses a wide range of approaches for the on-going evaluation of students' achievement and progress, including structured tests and quizzes; worksheets; home assignments; and informal assessing of student participation, effort, and behaviour. Judgments of students' achievement that are based only or mostly on classroom assessment could differ considerably across teachers. For instance, one may value information from class test less important than information from assignment whereas another assessor may assign the opposite weights to the same sources of information.

Teacher conceptions about assessment and the nature of learning in general can fundamentally influence their decisions about students' achievement. For example, subscribing to a view that every student should be held to the same academic standards and expectations is likely to influence the way in which a teacher judges the level of achievement of his/her students. Furthermore, teachers' perceptions about the relative value of standardized tests compared with classroom assessments will naturally influence

their assessment practices of students. A teacher who solely depends mostly on standardized tests could reach widely different judgments about students' achievement as compared to the one who places greater value on teacher made quizzes, effort, and participation in the classroom (Martínez, Stecher & Borko, 2009, William, 2011).

According to Fletcher (2001); Inekwe and Umar (2011), the mode of teachers' assessment prescribes the nature of the educational experiences and the quality of the relationship that exist between teachers' teaching and students' learning. They added that assessment is not something separate but a tool by which education may be evaluated; it acts upon the educational system so as to shape it in accordance with what the assessment demands. You cannot have, at one and the same time, educational system for personal growth and a totally impersonal system of assessment (Bennett, 2011). Assessment should therefore be a connection between teachers and what they have taught their students, not something which threatens and antagonizes students' efforts. To make assessment human oriented, then, we have to make schooling a more cooperative initiative between teachers and students, and opportunity to develop the whole range of human competencies, leading up to informative profiles. This should be the pattern of things for the immediate future; it is the way to discard the routine, and often unjust grading techniques of traditional education which does not benefit teachers and learners in anyway (NCTM, 1995, 2014).

According to (William 2016), the various and different evaluation objectives include but are not limited to a) student feedback; (b) diagnostic information; (c) record keeping summary data; (d) reporting evidence; and (e) curriculum review. Garrison & Ehringhaus (2011) states that teachers use evaluations to serve at least three distinct types of purposes in their classrooms: (a) to inform assessment, grading, diagnostics and referrals, sorting and grouping decisions; (b) to facilitate teaching and learning through communicating expectations and engaging students in self-evaluation and peer-evaluation; and (c) to retain management or regulation of behaviour in the classroom. We are of the opinion that what teachers use assessment to do must not only be limited to this categorization, but must go deeper to control the whole process of teaching and learning.

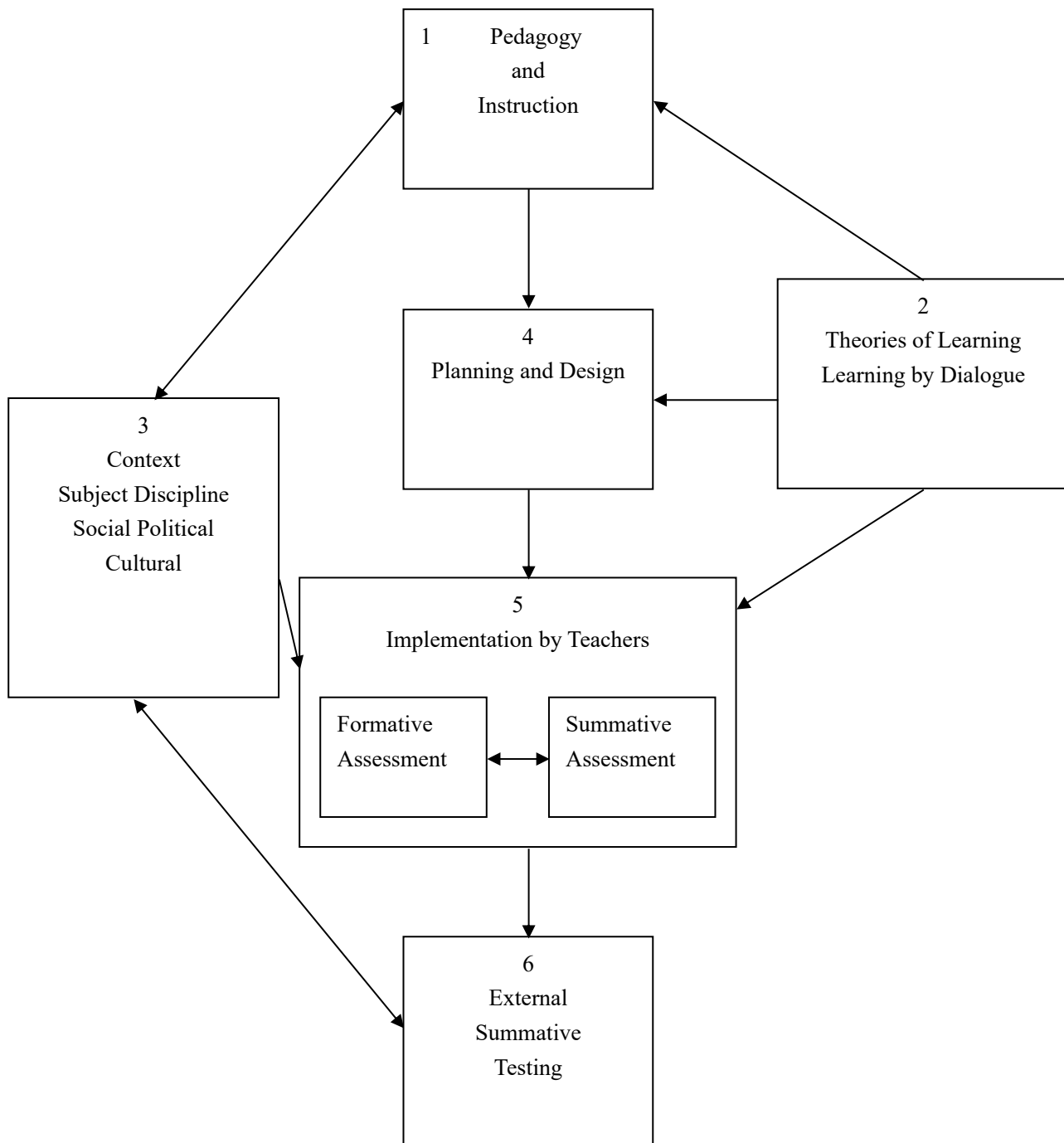
It must be noted that countries that are much concerned about their development put great deal of emphasis on the study of mathematics across all grade levels (Curriculum Research and Development Division, 2011). The rationale for the senior high school mathematics syllabus is therefore focused on attaining one crucial goal: to enable all Ghanaian young people to acquire mathematical skills, insights, attitudes and values they need to have to be successful in their chosen careers and daily lives. This rationale needs assessment system that will nurture the realization of the paramount goal of the mathematics curriculum at the Senior high school level.

Chief Examiners' reports in 2009, 2011, 2012, 2013 and 2014 indicate that Senior High School students performed abysmally in core mathematics over these years and the situation is not different from what happens at the basic level in Ghana. Many studies have been done to understand why students perform poorly in mathematics (Fletcher, 2001; Inekwe & Umar, 2011, Etsey 2003). The results show that some teacher factors such as content knowledge, pedagogical knowledge, pedagogical content knowledge, professional practices of which assessment is a key component that influence how teachers teach their students.

The results of the Trends in International Mathematics and Science Research (TIMSS) conducted in 2003 by the United States International Association for the Assessment of Educational Achievement (IEA) show that Ghanaian grade 8 children performed poorly in the mathematics achievement examination (TIMSS, 2003), where Ghanaian eighth graders were rated 43rd out of 44th graders. Trends in International Mathematics and Science Research (TIMSS, 2007) in an international study conducted in 2007. This condition is similar to what goes on at SHS levels in Ghana. It is more serious at the senior high school level where passing mathematics is a requirement for gaining admission into tertiary institutions. Failure to pass mathematics has resulted in many senior high school graduates being unable to continue at the tertiary level.

Ghana realizes the need to support mathematics education in high schools but without paying much attention to how students are assessed in the classroom. All teacher support programs and determinations may not adequately prepare teachers to meet the challenges they face in the classroom. There are many facets of education that need to be understood and addressed if teachers are to support students to learn meaningfully by integrating assessment in their teaching. For Ghana education to attain the standard it needs to achieve then it requires teachers who can ably conduct classroom assessment to inform their teaching and learning process.

According to Gbormittah and Bonney (2018), teachers who have gone through formal assessment training either as part of a programme package or as a course are expected to demonstrate high level of competencies with regards to classroom assessment. All teacher training institutions are making some attempt to equip prospective teachers the needed skills, knowledge and experience that they would need to do effective assessment. Workshops are organized for those who are even on the field of teaching to keep them abreast with modern based way of conducting ideal assessment of teaching and learning. Despite the significance of assessments in education today, few teachers put the skills, knowledge and experience from these training into effective use. Most of these teachers don't see the need to have teaching and learning processes that is assessment driven. Some teachers perceived assessment as added on activity that is mainly separated from the teaching learning process. Mathematics teachers who participated in this study prefer to set separate days sometimes few days or more days after teaching the concept or topic or sometimes they may not even assess their students at all on some of the concepts being taught and learned by them. This must not be case at all. These unfortunate practices have made students to develop the notion that their efforts have little or no influence on their results (Guskey, 2000a,2000b; William 2016). They added that students who participated in their study have little or no confidence in their assessment results. Consequently, students won't benefit from the assessment results. The teachers themselves won't be left out from what we called the gimmicking situation in academics. The teachers won't benefit as well as their students since the teachers' classroom assessment is not purposely oriented. So, who is the teacher deceiving? himself/ herself or the system? It is like we want to please the system in disguise of doing the right thing. Students are always disadvantaged and the consequence is the consistent poor performance of our students in mathematics. In fact, desired learning goals and assessment must go hand in hand. In other words, desired learning goals and assessment are mutually influential in teaching and learning mathematics. We tried to review literature on assessment models that could summarize the focus of our study. The Model for Assessment in Relation to Pedagogy was found useful and adopted for this study (Black & William, 2018).



**Figure 1: Model for Assessment in Relation to Pedagogy (Black & William, 2018)**

Whatever the relative merits of the wide and narrow definitions of pedagogy, a narrow definition of pedagogy would completely, or at the very least, exclude assessment, even if it included some elements of assessment, would exclude others, making it difficult to deal with assessment in an integrated manner. We therefore describe pedagogy generally for the purposes of this paper, and specifically as 'the act and discourse of teaching' (Black & William, 2018). Alexander (2004 p. 8) thus explicitly including curriculum and assessment, Specifically, we adopt Alexander's (2008) definition:

*pedagogy is the act of teaching together with its attendant discourse of educational theories, values, evidence and justifications. It is what one needs to know, and the skills one needs to command, in order*

*to make and justify the many different kinds of decision of which teaching is constituted. Curriculum is just one of its domains, albeit a central one. (p. 47 original emphasis)*

Not many studies have looked at the assessment practices of Beginning and Experienced Senior High School Mathematics teachers in particular. It is also unclear whether the poor performance of students in mathematics is as a result of the assessment practices of the Beginning and Experienced Senior High School Mathematics teachers. It is also unclear, whether the kind of students' assessment both the Beginning and Experienced SHS mathematics teachers do really mirrors the actual performance of our students. It is as a result of these issues that the study sought to investigate the assessment practices of Beginning and Experienced Senior High School Mathematics teachers. The following research questions and hypothesis guided the study:

1. What are the assessment practices of Beginning Senior High School Mathematics teachers?
2. What are the assessment practices of Experienced Senior High School Mathematics teachers?

H<sub>01</sub>: There is no significant difference in the assessment practices of Beginning and Experienced Senior High School Mathematics teachers.

## Methodology

A cross-sectional survey was the design used in this study since it was interested in describing a particular phenomenon under a study (Cohen, Mansion & Morrison, 2011). The cross-sectional survey is considered appropriate for this study since it deals with collecting a data from a sample that has been drawn from a population which was predetermine.

## Population

The target population was made up of all Beginning and Experienced Senior High School mathematics teachers in Abura/Asebu - Kwamankese district and Cape Coast metropolis in the Central Region of Ghana. The accessible population comprised of 100(60 Beginning and 40 Experienced) and 60(32 Beginning and 28 Experienced) Senior High School mathematics teachers in Cape Coast metropolis and Abura/Asebu-Kwamankese districts respectively all in the Central Region of Ghana.

*Table 1: Participating Schools in Cape Coast Metropolis*

Name of schools	No. of Beginning SHS Mathematics Teachers	No. of Experienced SHS Mathematics Teachers
HCHS	8	3
SAHS	8	2
ADHS	7	5
GNHS	7	3
MFHS	7	7
USHS	6	4
WGHS	6	9



CTHS	4	1
ETHS	4	4
OTHS	3	2
Total	60	40

Source: Fieldwork, 2015, N = 100

Table 2 - *Participating Schools in Abura / Asebu -Kwamankese District*

Name of the school	No. of Beginning SHS Mathematics Teachers	No. of Experienced SHS Mathematics Teachers
AGHS	8	4
ASHS	8	6
STHS	6	5
ABAHS	6	7
ABUHS	4	6
Total	32	28

Source: Fieldwork, 2015, N = 60

### Sampling Procedure

All the 92 Beginning and 68 Experienced SHS Mathematics teachers in the accessible population during the time of this study were sampled to take part in the study because of the small size of the population (Cohen, Mansion & Morrison, 2011) from Abura/Asebu - Kwamankese district and Cape Coast Metropolis. The researchers used simple random sampling technique in selecting the two districts. Therefore 160 (92 Beginning and 68 Experienced) SHS Mathematics teachers participated in this study from the two districts in the Central Region of Ghana.

### Data Collection Instruments

The research instrument used for this study was questionnaire. The questionnaire was named, "The Assessment Practices of Beginning SHS and Experienced SHS Mathematics Teachers". This instrument was developed by the researcher. The questionnaire consists of two sections:

- Five Demographic variables: gender, degree type, teaching experience, areas of mathematics being taught and academic qualification (see Appendix A).
- Consists of thirty-five (35) closed ended statements made up of various assessment practices each on a five-point Likert scale in which teachers were required to indicate the degree of frequency levels that best matches their typical assessment practices (See Appendix A)

### **Reliability and Validity of the Instrument**

The instrument was subjected to validity and reliability test. They were given to both supervisors who thoroughly vetted them and ascertained that they met both face and content validity. The suggestions as given by the supervisors with regard to the improper constructions of some items in the questionnaire were used to effect the necessary changes to improve upon the content validity.

### **Pilot testing of the Instrument**

Although the target population is made up of all the teachers in the Abura/Asebu-Kwamankese and Cape Coast metropolitan districts, pilot testing was carried out in two schools with each school from Komenda and Mfantseman districts respectively. EDSH and MFG Senior High Schools were randomly selected using computer pseudo random number generator for the pilot-testing. They had all the characteristics being looked for and were outside the two districts which participated in the study. The questionnaire was personally administered to total of 30 Mathematics (Beginning and Experienced) SHS Mathematics teachers with 14 mathematics teachers and 16 mathematics teachers from the two districts respectively. Response rate of 81% and 89% were achieved respectively. The result was analyzed to determine the content validity of the instrument. The internal consistency of the instrument was determined using the Cronbach co-efficient alpha. The Cronbach co-efficient alpha obtained for the pilot-testing were 0.86 and 0.91 respectively, indicating a high correlation among all of the items that make up the scale (Pallant, 2005, p6).

### **Data Collection Procedures**

The initial data collection process included obtaining permission from the department of Mathematics and I.C.T. Education, University of Cape Coast.

The questionnaire was administered to 92 Beginning SHS Mathematics teachers (60 from Cape Coast metropolis and 32 from Abura/Asebu-Kwamankese district) and 68 Experienced SHS Mathematics teachers (40 from Cape Coast metropolis and 28 from Abura/Asebu-Kwamankese district) [See table 1 and 2]. The respondents were allowed to participate in the study with the assistance of the heads of Department of the schools under the supervision of the researcher.

### **Data Processing and Analysis**

The data collected in this study was checked, edited, coded and analyzed with descriptive statistics based on the research questions and the literature reviewed for this study. The research questions were analyzed using descriptive statistics specifically frequency counts, percentages, mean and standard deviations to obtain descriptive statistics for the assessment practices of Beginning and Experienced Senior High School mathematics teachers. Independent sample t-test was further computed to determine whether there exists a significant difference between the assessment practices of the Beginning SHS Mathematics teachers and that of Experienced SHS Mathematics teachers. The following subscales were used for the data analysis: 1- very rarely (0-10% of the time), 2- rarely (11- 25% of the time), 3- occasionally (26- 50% of the time), 4- very frequently (51- 75% of the time) and 5- always (more than 75% of the time).

## Results and Discussions

### The Assessment Practices of Beginning Senior High School Mathematics Teachers

The first research question sought to investigate the assessment practices of Beginning Senior High School Mathematics teachers. This is to enable the researcher to explore the assessment practices of Beginning Senior High School Mathematics teachers. Table 3 shows the overall mean and standard deviation of the assessment practices of Beginning Senior High School Mathematics teachers.

*Table 3- The Overall Mean and Standard Deviation of Assessment Practices of Beginning Senior High School Mathematics Teachers*

Activity	N	Mean	SD
Assessment Practices.	92	2.2	0.3

Source: Field work, 2015, N = 92, M = 2.2, SD = 0.3

The overall mean and standard deviation recorded on the Beginning Senior High School Mathematics teachers' assessment practices were 2.2 and 0.3 respectively. The mean and standard deviation scores show that the assessment practices of Beginning Senior High School Mathematics teachers were more of rare practices than anticipated. It also means that majority of the Senior High School Mathematics teachers do not frequently integrate classroom assessment in the teaching and learning of Mathematics left alone integrating it always in their teaching and learning process.

Furthermore, a summary of item-by-item analysis was explicitly calculated for the assessment practices of the Beginning Senior High School mathematics teachers. The responses of the Beginning SHS Mathematics teachers were then categorized under five themes; Very Rare use of assessment, Rare use of assessment, Occasional use of assessment, Frequent use of assessment, and Always use of assessment in teaching and learning as shown in Table 4 below.

Table 4-shows the thematic analysis of the survey data from the Beginning SHS mathematics teachers.

Assessment practices	No of teachers N=92 N(%)	No of assessment practices N=35 N(%)
Very Rare use of assessment	6(6.5)	2(5.7)
Rare use of assessment	63(68.5)	24(69.0)
Occasional use of assessment	18(19.6)	7(20.0)
Frequent use of assessment	5(5.4)	2(5.7)
Always use of assessment	0(0.0)	0(0.0)
Total	92(100)	35(100)

The analysis of results in Table 4 shows that majority 63 (68.5%) of the Beginning Senior High School Mathematics teachers rarely use assessment to inform their teaching and students' learning. It means that majority of the SHS mathematics teachers scarcely use assessment to inform their teaching and students'

learning. The analysis of the results in Table 4 also indicates that 24 out of 35 of the assessment practices these majority 63(68.5%) of SHS Mathematics teachers were rarely applied in the teaching and learning of mathematics.

**Beginning Senior High School Mathematics teachers rarely used classroom assessment to:**

- a) Create conducive environment helpful for students to complete an assigned task.
- b) Provide students the opportunity to demonstrate what they have learnt in the Mathematics class.
- c) Guide students to set their goals and monitor their own learning where the teacher is only seen as an effective facilitator in the teaching learning process.
- d) To assist students in getting personal feedback.
- e) Demonstrate to students on how to do self-assessment.
- f) Set criteria for students to assess their own performance in class.
- g) Provide examples of good self-assessment practices for students to examine their own learning progress.
- h) Allow students to perform tasked based activities more than paper and pencil tests.
- i) Learn alternative approaches for assessing the learning outcome of students.
- j) Measure the extent of learning at the end of a lesson.
- k) Evaluate the level of competence of students.
- l) Determine the level of accomplishment of a desired learning outcome.
- m) Assess the quality of students learning in class.
- n) Allow students to discover their learning difficulties in class.
- o) Help students to improve their learning process in class.
- p) Assist students to determine their learning strengths in class.
- q) Suggest to students about how they can develop better learning strategies.
- r) Provide specific information to students about their strengths and weakness in class.
- s) Enhance the quality of classroom instruction.
- t) Explore effective classroom teaching methods.
- u) Diagnose areas for improvement of instructional activities.
- v) Identify better learning opportunities for students in class.
- w) Collect continuous learning data from students and
- x) Rank students based on their performance in class.

It was also found out that 2 out of 35 assessment practices of the

Table 4 indicate that minority 6.5% (6 out of the 92) Beginning Senior High School Mathematics teachers very rarely use assessment in the teaching and learning of Mathematics. In other words, 5.7% of the assessment practices of the Beginning Senior High School Mathematics teachers were very rarely applied in their teaching.

**Beginning Senior High School Mathematics teachers very rarely used classroom assessment to:**

- a. Perform classroom observation to determine how students learning can be improved.
- b. Determine how students can learn on their own in class.

The analysis of results in Table 4 also show that Beginning Senior High School Mathematics teachers occasionally practice assessment in 7 out of 35 of their assessment practices in the teaching and learning of Mathematics. This means that, a fifth of their assessment practices were occasionally used in the teaching and learning of mathematics.

**Beginning Senior High School Mathematics teachers occasionally used classroom assessment to:**

- a. Help students to develop clear criteria of good learning practices.
- b. Improve instruction for the next teaching term.
- c. Make final decision about the level of students learning at the end of a lesson.
- d. Provide feedback to students.
- e. Create effective teaching approach and strategies for teaching students.
- f. Provide information to parents about their children performance and
- g. Have an accurate basis to show the achievement of students in a class.

The analysis of results in Table 4 revealed that 2 out of the 35 assessment practices of the Beginning Senior High School Mathematics teachers were very frequently used in the teaching and learning of Mathematics. This means that 5(5.4%) of the Beginning Senior High School Mathematics teachers very frequently practice classroom assessment in the teaching and learning of Mathematics. They frequently use classroom assessment to:

- a) Examine how students perform relative to others and
- b) Supply information to other teachers, schools, employers regarding students' performance in class.

Analysis of results in Table 4 shows that none of the Beginning SHS mathematics Always use assessment to inform their teaching and students' learning.

**The Assessment Practices of Experienced Senior High School Mathematics Teachers**

The second research question sought to investigate the assessment practices of Experienced Senior High School mathematics teachers.

Table 5 shows the overall mean and standard deviation of the assessment practices of Experienced Senior High School mathematics teachers.

*Table 5: The Overall Mean and Standard Deviation of the Assessment*

*Practices of Experienced Senior High School Mathematics Teachers*

Activity	N	Mean	SD
Assessment Practices	68	2.4	0.2

Source: Field work, 2015, N = 68, M = 2.4, SD = 0.2

The analysis of results in Table 5 indicate that the mean and standard deviation scores recorded on the Experienced Senior High School Mathematics teacher's assessment practices were 2.4 out of 5 and 0.2 respectively. Generally, the mean and standard deviation showed that the Experienced Senior High School

Mathematics teachers' rarely use assessment in the teaching and learning of Mathematics. These are set of teachers who are expected to put up good classroom assessment practices in the teaching and learning of Mathematics with regards to the number years of experience as mathematics teachers. These teachers have had all the exposure either from training or the field and are expected to effectively integrate assessment in the teaching and learning of Mathematics.

Furthermore, a summary of item-by-item analysis was computed for the assessment practices of the Experienced Senior High School Mathematics teachers and the responses of their practices were also explicitly categorized under five themes; Very Rare use of assessment, Rare use of assessment, Occasional use of assessment, Frequent use of assessment, and Always use of assessment in teaching and learning of mathematics as shown in Table 6.

Table 6 -shows the thematic analysis of the survey data from the Experienced SHS mathematics teachers.

Assessment practices	No of teachers N=68 N(%)	No of Assessment practices N=35 N(%)
Very Rare use of assessment	4(5.9)	2(5.7)
Rare use of assessment	33(48.5)	17(48.6)
Occasional use of assessment	23(33.8)	12(34.3)
Frequent use of assessment	8(11.7)	4(11.4)
Always use of assessment	0(0.0)	0(0.0)
Total	68(100.0)	35(100)

The analysis of results in Table 6 **indicates** that a little less than half 33 (48.5%) of the Experienced Senior High School Mathematics teachers rarely use assessment in teaching and learning of mathematics. In other words, significant majority 17 (48.6%) of their assessment practices were rarely used in the teaching and learning of Mathematics.

**The Experienced Senior High School Mathematics teachers rarely used classroom assessment to:**

- Provide students the chance to show /demonstrate what they have learnt in class.
- Guide student to set their goals and monitor their own learning progress.
- Demonstrate to students how to assess their own performance.
- Set the criteria for students to assess their own performance.
- Provide example of good self-assessment practices for students to examine their own learning process.
- Allow students to perform task-based activities more than paper and pencil tests.
- Measure the extent of learning at the end of a lesson.
- Evaluate the level of competence of students of instructional programme.
- Improve instruction for the next teaching term or school term.
- Determine the level of accomplishment of a desired learning outcome.
- Assess the quality of students' learning in class at the end of instruction.



- l) Make final decision about the level of learning that students achieved.
- m) Allow students to discover their learning difficulties in class.
- n) Provide specific information to students about their strengths and weakness in class.
- o) Enhance the quality of classroom instruction.
- p) Explore effective classroom teaching methods and strategies and
- q) Identify better learning opportunities for students in class.

The analysis of results in Table 6 show that 4(11.4%) of the assessment practices of the Experience Senior High School Mathematics teachers were very frequently applied in the teaching and learning of mathematics. This means that only 8 out of 68 Experience Senior High School Mathematics teachers' assessment practices very frequently use assessment in the teaching and learning of mathematic. The analysis of results in Table 6 also shows that none of the Experienced SHS Mathematics teachers Always use assessment in the teaching and learning.

**Experienced Senior High School Mathematics teachers very frequently used classroom assessment to:**

- a) Provide information to parents about students' performance of their children.
- b) Have an accurate basis to show the achievement of students.
- c) Examine how students perform relative to their others in class and
- d) Supply information to other teachers, schools, employers regarding students' performance in class.

The analysis of results in Table 6 show that 23 (33.8%) of the Experienced Senior High School Mathematics teachers occasionally use assessment in the teaching and learning of Mathematics. In other words, 12(34.3%) of the assessment practices of Experienced Senior High School Mathematics teachers were occasionally applied in the teaching and learning of mathematics.

**Experienced Senior High School Mathematics teachers used classroom assessment occasionally to:**

- a) Create an environment which is helpful for students to complete an assigned task.
- b) Help students to develop clear criteria of good learning practice.
- c) Assist students to identify means of getting personal feedback.
- d) Determine how students can learn on their own in class.
- e) Learning alternative approaches to assess learning outcomes of students.
- f) Provide feedback to students in order to improve their learning process and class performance.
- g) Make suggestions to students about how they develop better learning strategies.
- h) Diagnose areas for improvement of instructional activities.
- i) Collect continuous learning data from students to improve instruction.
- j) Create effective teaching approach and strategies for my class and
- k) Rank students based on their performance to inform other officials.

The analysis of results in Table 6 show that 2 out of the 35 practices of the Experienced Senior High School Mathematics teachers were very rarely used in the teaching and learning of mathematics.

**Experienced Senior High School Mathematics teachers used classroom assessment very rarely to:**

- a) Assist students to determine their learning strengths for my class and
- b) Perform classroom observation to determine how students learning can be improved.

**Senior High School Mathematics Teachers' level of Experience and their Assessment Practices**

Teachers' ratings on the items were aggregated to form the variable 'The Assessment Practices of Beginning and Experienced Senior High School Mathematics Teachers'. This computed variable was further investigated to determine whether or not there is a significance difference between the Assessment Practices of Beginning and Experienced Senior High School Mathematics Teachers' by the number of years that they have been teaching Mathematics in the Senior High School. Independent sample t-test was used in testing the null hypothesis: There is no significant difference in the assessment practices of Beginning and Experienced Senior High School Mathematics teachers.

*Table 7: Comparative analysis of Assessment Practices of 'Beginning' and 'Experienced' Mathematics Teachers*

Assessment practices	N	M	SD	T-value	P-value
Beginning Teachers.	92	2.2	0.34	0.423	0.033
Experienced Teachers	68	2.4	0.23		

Source: Fieldwork, 2015

Table 7 shows the test for equality of means among the Beginning SHS Mathematics teachers (those who have taught for less than 5 years) and Experienced SHS Mathematics (those who have taught for 5 years and above) groups. Since the equality of variance assumption is validated the researcher used the first 2-tailed significant value of a test for equality of means at p-value of 0.033 which is less than significant level of 0.050. The researcher therefore has enough evidence to reject the null hypothesis. In other, words, we reject  $H_0$  at the 5% significance level and conclude that there is a significant difference among Senior High School Mathematics teachers who have taught for 'less than 5 years' and those who have taught for '5 years and above'.

Lastly, there is the need to determine the value of Eta square, which is the proportion of variances of the dependent variable explained by the independent variable. The value of the Eta Square (0.048) shows the proportion of the variance in the assessment practices of the SHS Mathematics teachers explained by their teaching experience. The Eta square is moderate,  $t(158) = 0.423$ ,  $p = 0.033$  (two-tailed),  $d = 0.050$ , indicating that though there is a difference in the assessment practices of those who have taught for less than 5 years and that of 5 years and above but the difference is not significant.

**Summary of key findings**

The mean and standard deviation of the assessment practices of Beginning Senior High School Mathematics teachers are 2.2 and 0.3 respectively which indicate rare use of assessment in the teaching and learning of mathematics. In other words, majority (87 out of 92) of Beginning Senior High School Mathematics teachers do not either frequently or always integrate assessment in the teaching and learning of Mathematics. The mean and standard deviation of the assessment practices of Experienced Senior High School Mathematics teachers are 2.4 and 0.2 respectively which generally show rare use of assessment in the teaching and learning of mathematics. In other words, majority (60 out of 68) of the Experienced SHS Mathematics teachers do not either frequently or always use classroom assessment in the teaching and learning of mathematics. The best assessment practices of Beginning SHS mathematics teachers were applied to examine how students perform relative to others, and supply information to other teachers, schools, employers regarding students' performance in class whereas that of the Experienced SHS mathematics teachers frequently use assessment to provide information to parents about students' performance of their children, have an accurate basis to show the achievement of students, examine how students perform relative to others in class and supply information to other teachers, schools, employers regarding students' performance in class. Finally, there was a significant difference between the assessment practices of the Beginning SHS Mathematics teachers and that of Experienced SHS Mathematics teachers but the difference was not much.

**Conclusion**

Both the Beginning and Experienced Senior High School Mathematics teachers rarely use assessment to inform their teaching and students' learning. In other words, majority of Beginning and Experienced Senior High School Mathematics teachers do not either frequently or always integrate assessment in the teaching and learning of Mathematics. Experienced SHS Mathematics teachers mainly use classroom assessment to provide information to parents about students' performance of their children, have an accurate basis to show the achievement of students, examine how students perform relative to others in class and Supply information to other teachers, schools, employers regarding students' performance in class. Finally, even though there was a significant difference between the assessment practices of the Beginning SHS and that of Experienced SHS Mathematics teachers but the difference was not much. Based on the findings, it was recommended that intensive In-service training should be organised for both the Experienced SHS Mathematics teachers and the Beginning SHS Mathematics teachers to help them bridge the gap that exist between their practices.

**Implication for Teaching and Learning**

Beginning and Experienced SHS mathematics teachers must use assessment to inform their teaching and learning in context to help their students to make meaning of their own learning. Teachers must use the assessment to facilitate students' learning. Effort must be made by head of schools, head of departments to bridge the gap between the assessment practices of the beginning and experienced SHS mathematics teachers so that their practices will reflect the teaching standards of a good teacher. Assessment must be

used to improve students' learning and the teaching practices of the teachers. SHS Mathematics teachers' assessment practices must be purpose driven to improve teaching and learning. SHS Mathematics teachers must therefore avoid using classroom-based assessment mainly as a way of ranking students and schools rather they must use assessment practices that will mirror the true image of their students' learning abilities in a wholistic manner. Students must see classroom-based assessment as a means of improving learning and value its potentiality of correcting the way they learned. Students must desire to get feedback from whatever they were asked to work on. This feedback could come from the teacher or any experienced peer or the learner himself/herself who could do authentic assessment of the situation which can improve learning.

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# **The effects of Product Development, Product Promotion & Product Innovation initiatives on the product life-cycles**

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## **Abstract**

*The paper is aimed at elucidating the measures that the marketers take to Develop & Promote products and do product differentiation through product innovations to manage favourably the product life cycles - fighting competition both for sustenance in the market and/or to enlarge market shares. They choose to create better and consistent customer awareness with emotional appeal on the one hand and add value to the products bringing in new or altered product features when needed to deliver enhanced benefits that the buyers in the market look for. That is, in order to give the products / brands prolonged life cycle, the marketers develop their products, do promotions and also product innovations (to add value to products for better performance, look & feel of them), in a bid to differentiate them from those other similar competing products/brands. Product life cycles are the captured performance graphs for the products, which could be considered as prescriptions for corrections of products and brands in their tangible and intangible features so as to make them spring back to perform to the levels. The paper thus focuses on the practices that the marketers undertake to do in order to win the hearts of the buyers. The larger objective of the paper is to throw light on all the initiatives of the marketers which they would do to match the customer preferences*

**Keywords:** Product Development – Product innovation – product differentiation – product lifecycle – consumer preference

## **Introduction:**

Products and Services are essential in our lives. Some products / services sustain lives, some provide safety, some of them provide ease and comfort, and yet some enhance esteem. Since human needs and wants are multitudinous the products and services that people look for keep growing in number. Such products and services are chosen based on considerations of quality, price, availability and what all they do to their lives. Dependence of one on others for products and services– as individuals or organizations - is an age old practice. The secret of happiness in the material world is to make products and provide services to others



and also be provided with products and services by others. It is humanly impossible for people to meet all the needs themselves without depending on others. We need products which deliver benefits and beneficial services, and we also need people's professional services. Daily lives of all of us are therefore dependent on products and services. Without products and services our lives will be a big clutter. They are mainly intended to meet the basic needs and also to ease and comfort us. They also enable us to plough back time to take care of our other interests in life. Products and services also connect people. What we do is in turn an offer of service to others – be it individual or an organization (an organized group of people)

Marketers develop products (and services) which people buy and use. Providing of products and services are both different from each other. Certain needs of people will be better met through the services offered by people, rather than products intended to deliver such service. For our study here we look at both product and service as an offer of benefit to the buyers, who own/hire them to meet their needs and wants. In a market there will be different brands of the same products offering more or less similar product features showing advantages and delivering benefits. Among the brands in the market, some sell the most and others sell in different quantities and such differences exist because of the customer preferences being different and also the emotional influence that plays in the purchase of certain brands by the buyers. Deeper study reveals that logically the features of such products/brands could be more or less same, at least not justifying the difference in quantities bought by customers. So there are several factors that shape the consumer preferences which drive the performance of products in the market and the product life-cycles of each of them hence follow different patterns. While it could be logically assessed why a product/brand is performing the best to a larger extent, there will be an amount of hazy rationale which still plays significantly making different products/brands perform differently, which the logic cannot fully explain. Product life cycles are the captured performance graphs for the products, which could be considered as prescriptions for corrections of products and brands in their tangible and intangible features so as to make them spring back to perform to the levels.

A product or a service is built with great care to ensure that it has the required features providing a core benefit and over which are built other features to make it a product with a primary benefit together with auxiliary benefits making it a consummation of benefits offered through the product/service. One who buys a product will enjoy the core benefit of the product that it is intended for and also the other auxiliary benefits that the other features added provide. So a product – in marketing – is defined as anything that is offered at a price and which primarily provides the core and the added benefits. One who has the specific choice of brand of a product when buying, he or she is supposed to have been impressed / influenced by the intensity of the core benefit of the branded product and also with the added benefits that they can enjoy, which the product delivers through the features that it is made up of. The profile of any product and service therefore constitutes **the core product** (innermost & basic benefit) and **the actual product** which is built with other features such as Quality, Colour, design, etc.

## **Research Method:**

Study and Review of Literature and also the current market happenings in regard to the marketing techniques that the marketers are adopting, have been kept in the background to make clear the rationale

responsible for the different patterns of product life-cycles which could be witnessed. All the initiatives are the positive and proactive responses of the marketers to meet the consumer preferences.

## Results & Discussions

### Products are not static

Products are meant for providing service which is expected to be one of quality, for an expected period of time and to give an overall feel of comfort for the users. Products do not change unless the marketers intend to bring changes; marketers will not intend to alter the product features unless customers choices are indicative of that, or there is a danger of the competition eating into the market share existing for the product / brand at any given time. But with the market becoming more competitive on qualitative, pricing and other factors, every marketer is forced to think in terms of indulging to do changes in the required area of the product profile. As is known, any product profile is built with three layers of features – Core Product; Actual product & Augmented product. In the normal circumstances, products fighting in competition would add / alter features in any one of the three areas, through which they could claim that they are unopposed in the competition with respect to that particular feature that they add into the product profile. With the marketing communications focused on the special features added, the marketer of the product / brand could make the customers to get interested in trying out the product for the advantage and benefit that the added feature/s delivers.

Ref.No.1:

Product life cycles are the captured performance graphs for the products, which could be considered as prescriptions for corrections of products and brands in their tangible and intangible features so as to make them spring back to perform to the levels needed. It is therefore a scenario and trend showing graph for products post product-development & introduction. Product development is done based on expected service and value that the customer looks from the product. In other words the product that is developed and introduced in the market is constructed with the features expected to meet the needs and wants of the buyers. The focus of the marketer in doing so, would be to essentially ensure that the **functionality intended of the product is built and strengthened to provide an optimum level of service quality for an optimum level of time period.** But the real picture about the response from the buyers – i.e. purchase, re-purchase and satisfaction derived by the buyer, will be visible only from the product life cycle that is captured from the product's performance in the market. Product life cycle will indicate different stages of the life. A short life of a product understood from the 'product life cycle' studied indicates that the number of buyers is decreasing since they are finding the product less beneficial or the interest and inclination to buy the specific product is decreasing, when compared to other products / brands in the market. The behaviour of the buyers will be an indicator for the marketer to know for sure the correct reason – why; and take necessary corrective action, if the product has to be elevated with the innovated features more than the awareness about the product among the buyers. If awareness is found to be the problem, the first action of the marketer to correct would be enhancing the marketing communications about the availability, quality

and price to pull the buyers attention and interest through logical and emotional appeals through the creatives.

When communications are found to be adequate, despite which, the sale volumes are falling, the reason could be that competitors are eating into the business of the organization, in which case, market research would throw light on what should be the corrective action. Invariably, such **research would reveal a need to do an innovative correction in the actual product** area, through which the product/brand could get back its share of market. **For instance, during this time when Covid-19 Viral infection is prevalent, any soap with efficient germ killing feature would sell better than those not having the required feature.** Product innovation is therefore a moderating tool for correction in the market for products.

*“Economic theory has primarily viewed an innovation as a single, discontinuous change. Historical and empirical evidence, on the other hand, shows improvements to original technologies and quality additions to early products. We focus analysis on competition in post-discovery phase, emphasizing in particular that a key dimension to this competition is the innovations that lead to product differentiation and quality improvement.”*

#### Ref. No.2

“Past studies on product life cycle are mostly conducted from the angle of product features, less are from the perspective of consumers’ preferences. In essence, while product life cycle becomes shorter and businesses continue to strive for survival and growth, a thorough understanding of the market circumstances and the preferences of the consumers will enable businesses to design new products that meet the market need and to satisfy the need of the customers (Kotler, 2000).”

#### Ref. No.3

**Study reveals that on deeper analysis, we could bring clarity on the abstract rationale which could be ratified through an empirical study:**

##### **(1) Classical pattern: Bell-shaped curve**

This is the normal product life cycle – where in products are introduced packing the product profile with the expected features in the three regions of profile – **Core Product, Actual product and Augmented product**, and doing the marketing communications and promotions needed – more during introduction and Growth phase – in a calibrated manner, and continuing the efforts in the maturity phase and the decline happens – as shown by the sloping curve.

The pattern shown here explains the customer’s mind which follows the pattern like – 1. Receiving first Information about the product, getting impacted by what the product can do, getting interested to know more and look for the possibility to acquire; getting driven through facilitation (which creates demand for the product) and acquisition of the product for usage, repeat usage. After a while straying to get attracted to other products / brands, which could be new or augmented and upgraded. The loss of customers to a product or brand happens with the inevitable pull of the Actual and Augmented product features of other competitive products.

**(2) Cycle-recycle pattern:**

In this pattern of the PLC – the first and the original cycle gets completed with marketing efforts put forth as indicated in the classical pattern with the promotions carried out as required. The second cycle would start and repeat to depict the overall performance as the first Cycle, but the range & life duration will be shorter than the first one. Such cycles could be repeated with the efforts put in as done for the second cycle, but the ranges and life durations become lesser and lesser – depicting the decreasing impact of the product on the overall product.

The pattern here is, repeat cycles are smaller and shorter. The rationale is the promotional efforts done to pull the customers who did repeat purchases – reasons could be a strong feature of the product /brand masking the strengths of the other new products with better profiles, sub-conscious acts of purchase and other marketing weaknesses of the new products throwing doubts in the mind of the customers.

**(3) Growth-decline-plateau pattern:**

When a product is introduced to the market, the sales volume increases rapidly and declines to a stable state. The stable state of sales volume is created because of the initial purchase of the later adopters and the replacement purchase of the earlier adopters. In this pattern of PLC, rationale is similar to the “Cycle-Recycle” pattern apart from the loyalty of some of the customers remaining with the first product brand apart from “initial purchase of the later adopters and the replacement purchase of the earlier adopters.”

**(4) Innovative maturity pattern:**

If the sales volume either keeps growing or showing only small gaps of neutrality in between with no signs of decline the pattern is called Innovative maturity pattern. Reason could be on account of discovery of new product feature, new uses, or new users. This essentially happens with the focus of the marketers on the Functionality preference of the buyers.

**Need for addition / modification in features**

So the need for altering the features of the product profile – either through adding, removing or changing the features becomes imperative. This act of addition / modification of the features is to differentiate the product/brand from other fighting competitors, thus indulging in innovation. Invariably, the need for such an eventuality would arise only from the product/s / brands which are closer and with similar market shares. The product differentiation at that time becomes mandatory otherwise the brand could lose business volumes. Product differentiation through innovation, hence, keeps happening in a dynamic market scenario.

Ref.No.4

### **Added pressure on the manufacturers:**

Product differentiation means additional pressure on the manufacturers to take decision as to which attribute needs to be innovated and shown as USP. Product differentiation may provide scope for increasing price, but then that depends on what the competitor did.

Ref. No.5

### **Added Features give scope for added value / revenues**

No feature is added or altered without a strong objective as the purpose is to add value expected to garner more sale volumes and revenues. Adding Features for the sake of just adding will be a wasteful exercise unless it is a part of strategy, otherwise it would be a self-defeating exercise. And every such feature added / modified should bring in a strong beneficial outcome, which the customer/s would welcome. Product differentiation through innovation, therefore, will be a definite need for the marketers at a time when the competition products / brands do so.

Ref.No.6

### **Features are “Features-advantages-&-benefits”**

Adding features is an act - built on a desire to upgrade the product status. It is both logical and emotional to think of adding features. For a physical product, the features are mostly added in the actual product, as this part of the product profile only means an added value to the customer, as the customer would derive a visible benefit which appeals more, rather than one done on an abstract area of the product. Adding feature to the Core product area too is done, but the marketer cannot get into the act impulsively, as it would sometimes be a disaster, as the core product is the one that fulfills the need of owning the product. Core product is closely connected to the “Functionality of the Customers preference”. Any change wrongly done could end up in a great loss even in getting rejected by the customer – forgetting all the glory of the past. So any feature added is carefully done examining and testing the advantages and benefits out of them which are distinct and visible. Further, change in core product will be, normally, seen as a different product altogether – rather than working on the existing product.

Ref.No.7

### **It should look “more value for the same amount of money spent”**

Customer perception is one very important thing that the marketers always keep in mind. The product differentiation and the corresponding feature addition or alternation, if visible, or could be strongly felt and perceived, then such a change would result in a greater advantage to the marketer. The objective is to either maintain the share of sale volume or increase the sale volume depending upon what makes the marketer to indulge in the product differentiation through innovation.

Ref: No.8

**More benefits does not mean higher price**

Product differentiation effort does not mean price change, though most of the times it calls for that. In fact the product differentiation is more to retain the market share than to aim for increased sale volumes and sale values, though that also is expected. When the product is well accepted, then the marketers think of price revision suitably at the appropriate time.

**More for less should be the objective**

In times of recession and also when the marketer of a product / service wants to alternately position the company's brand could resort to "More for less" concept. Offering a product or service at a price, which is seen as a "throw away price" could be in the normal circumstances priced marginally higher, as the perception of the customer would still be positive and engaging. So offering more in quantity or value for a product or service for a price which is perceived as less, shows the strong objective of the marketer and the desired result could be for a niche positioning that is aimed at.

*"During the economic downturns of the early 1990s and early 2000s, law firms tightened their belts and priced themselves more competitively, but did not change the way they worked. In contrast, this recent recession has spawned alternative ways of sourcing routine work, innovative uses of technology, new entrepreneurial suppliers of services, and different delivery and business models. Clients have benefited from these, or at least have seen clearly what different might look like. By and large, they like what they see: more legal service at less cost. Why on earth would they go back to less efficient, more costly service? And even if they were inclined to time travel back to 2004, their CEOs and stockholders are unlikely to tolerate this. The genie is out of the bottle"*

Ref.No.9

**Product Variant**

Developing "Product variants" is an alternate way to fight competition. If the competition product has started doing better for a definite reason, and such a situation is not on account of lack of marketing communications and normal promotions, then the marketer of the product would have two choices to adopt – one - do a product innovation and two develop a product variant. In a market scenario where a company's sale volumes are showing signs of decline, the marketers doing a smart market research could discover a strong rationale leading not to a need for innovation within the product profile, but an all new product / model, which could be closer to the first one (in functionality) but yet a strong feature that makes it a variant and of different genre. Product variants are mostly closer to the earlier product in the functionality part but could vary in visibility endowed with a strong additional feature. This kind of marketing strategy could turn out a brilliant outcome, which could change the whole fortune of the company.



The classic example for success on innovation in bringing out a Classic SUV – could be quoted here. “Scorpio”, the dream of an SUV, as the Company - Mahindra & Mahindra Ltd. - experienced the great success of it through its performance:

“It took 120 people. 19 teams. 7.4 billion Rupees. 75 prototypes. Managing design and development, testing and validation, manufacturing and supplier development in-house. And going global with its creation, partnering with our suppliers every step of the way.

“We made innovators of not just ourselves, but of our suppliers too, making Project Scorpio a truly global story.”

“Designed in India and the UK. Engineered in Germany and Austria. With American interiors. Seats made in Italy. Panels in Sweden. A body in Korea”

Together, we produced a 109 horsepower best-in-class engine that met global Euro III emission standards. It also looked great, because as a prospective customer put it, “No one sees my house, but everyone sees my car.”

Ref.No.10

### **Are the products’ Lives end-less**

The life cycles of products though are not endless, some very popular brands stay long enough to give a feeling that they live ever. Every time the product with its profile either finds a strong contender in the market or the marketer decides to give it new avatar, the product is innovated with new features, advantages and benefits to engage the customers and make them feel that the product that they buy is a leader-brand – the brand that is unique and world class. So to fight the competition the marketers differentiate the product with new features and to lead in a new pathway, the market leader does innovation. Thus the product life-cycles are redrawn and the rejuvenated – either by differentiation or by innovation and the product thus takes a new avatar.

Ref.No.11

“The relationship between product innovation and product life-cycle pattern

Rochford and Linda (1991) discussed product innovation from the various perspectives of consumers, businesses, and market. From the perspective of the consumer, product innovation refers to providing new products that are more effective for the consumers (Benner and Tushman, 2003; Zheng, Yim and Tse, 2005); from the perspective of the business, product innovation refers to greater novelty of a product’s related market, technology, and production method; from the perspective of the market, product innovation is evaluated from the fact if the new product contains functions that are not seen in the existing products. David (2005) believes that product innovation is the “incremental changes and improvements” in product,

service, and process. It includes creative response and solution to meet the need and expectation of the consumers and the market, the driving force of the business circumstances, and requirement of the organization strategy."

### How strong and long living brands sustain in and rule the markets

For a Strong and long living brand like "Colgate", it has been the customer-centric culture of the company, which made the consistent customer focus to keep providing benefits to customers. It is - Product development, innovation, pricing and various other features - that kept addressing the customers' interests which made the brand Colgate a supreme brand. The product life cycle patterns have been reflecting the trends meeting of all the customer preferences which is the secret of the longevity of the strong brand equity.

"Colgate Company is a typical market oriented company, operating in more than 200 countries. They are providing many new employee oriented programs both for senior level and entry level people. They are aware of their social and ethical responsibilities. They are managing the consumer and business market in an effective manner. They face their competitors and feel proud to take it as a challenge. They feel pride in making their customers happy. They know how to conduct their business in international communities. They maintain levels of the CRM at the company to ensure good customer support. The way they have proved themselves in consumer, business and international markets, they still have a high aim to attain more and more"

Ref.No.12

### Consumer preferences vs. Product Life Cycle patterns

On a general observation one could see that when the consumer choice has a greater emphasis on financial preference, functionality preference and external look preference, the PLC patterns would be correspondingly – Growth-decline-plateau pattern, Innovative maturity pattern; and cycle-Recycle pattern, in the order mentioned.

Consumer preference	PLC pattern
Financial preference	Growth-decline-plateau
Functionality preference	Innovative maturity
External look preference	Cycle-Recycle

Functionality preference shows a greater significance in relationship, in comparison with the other preferences of the consumer. **The product life cycle** shows an **Innovative maturity pattern** with product finding new uses and new users.

Product Innovation preference shows similarly a relationship of significant nature with the Product life-cycle. PLC here shows a Cycle-Recycle pattern initially followed by Classical pattern. Product

Innovation preference exhibits a moderating effect and it balances consumer preference with the product-life cycle

Financial preference and its relationship with Product lifecycle may not show any significance initially, but with the moderating effect of product innovation on the Product life cycle, financial preference also starts showing up its significance and it grows gradually.

### **Ref.No.13**

#### **Does emotion win logic**

It is also felt strongly that 80% of the purchase process is emotional. If this aspect of purchase process is ignored by the marketer, it would be a disaster. The buyers, however analytical they are, would exhibit their individuality by attaching an emotional bond to products and brands. Of course the functionality and the price would be an initial take but the winning strike will be the emotional indulgence ultimately. So the emotional appeal has to be of great importance. Even the selection and the evaluation which are supposed to be logical aspects are often done with an emotional outlook.

#### **Conclusion**

Core products provide basic utility value – Food satiates hunger; Water quenches thirst. A vehicle meets the travel need, a mobile phone meets the communication needs. All these – as products – in general act as core products. While core products meet the functionality needs, many times the core products cannot be offered as they are, but over which several features have to be built up without which the core product may be found to be too crude and requires the desired value additions. The value additions become very essential and they would sometime become most essential without which the core product could itself be done away with. Water quenches thirst, but water needs to be made clean and drinking water, so there is an element of value addition, through a process, which is an essential requirement. Similarly most of the products even the naturally available things need to be at least processed before we could use them or consume them.

Products and Services appeal to the buyers in terms of what they do to their needs. While logical needs are essentially to be fulfilled, emotional needs and abstract value additions could score over the logical requirements and win the hearts of buyers. Studies reveal that even the selection and evaluation are sometimes done emotionally.

The paper detailing on all aspects of Product profile – the core and the actual product features – corroborates to say that the buyers first and essentially look for the functionality needs which the products and their features are meant for. And it is found that the Functionality needs, if met by the products, their product life cycles show greater presence in the market than the other preferences such as product innovation preferences and financial preferences. If the functionality needs are met, there is a rare chance of the buyers to look for alternate products and services, but when there is competition which matches the

products having greater functionality aspects, then the consumer preferences would look for Product Innovation aspects of the matching products / brands and later the financial preferences would start having its impact. The paper thus concludes that the products with Functionality uniqueness and emotional appeal would rule the market and others try to retain their positions by product innovation and price wars. But then the buyer enjoys the unique position to wait and watch to get the best of value that would be possible from the products or services. And the marketers sometimes win over the buyers with emotional dealing with the buyers, as the buyers often fumble by making buying decisions through selection and evaluation also done through emotional approach.

It is therefore visible in the discussions that the marketers have to necessarily respond positively in the Product development stage and also while innovating product being present in the market, to the customer preferences which will keep focusing on all aspects of their choices – Functionality preferences; Product Innovation preferences and finance preferences. The products with the ideal mix of offers would rule the market and others follow in the race.

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# **Relationship Between Peer Counseling Activities and Pupils' Discipline in Public Primary Schools in Mathioya Sub-county, Murang'a County, Kenya**

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## **ABSTRACT**

*Cases of disruptive behavior problems such as inattentiveness, bullying, violence, drug abuse, hitting other pupils, teasing others, yelling and complaining amongst pupils in public primary schools in Mathioya Sub-county are on the rise. The purpose of this study was to evaluate the relationship between peer counseling activities and pupils' discipline in public primary schools. A sample size of 196 respondents were selected. The study established that there was significant relationship between peer counseling activities and pupils' discipline at the  $p < 0.05$  [ $r = 0.001$ ,  $p = 0.001$ ]. This indicates that, in public primary schools where teachers frequently engage in peer counseling activities, pupils manifest few cases of indiscipline. The implications of this finding are discussed.*

**Keywords:** Peer counseling activities, pupils' discipline, Mathioya Sub-county

## **1.0 Introduction**

Discipline is an important component of pupils' behavior and without it a school cannot function well towards the achievement of its goals. In the context of a school system, a disciplined pupil is that pupil whose behaviours, actions and inactions conform to the predetermined rules and regulations of the school (Ali, Dada, Isiaka & Salmon, 2014). Cognizant of these assertions, Masitsa (2011) posits that pupils' discipline is widely acknowledged to be essential for creating a positive school climate conducive to sound learning outcomes. Pupils' discipline has highly deteriorated due to decline in moral virtues which are attained through teaching of moral character. According to Lickona (2011), acts of indiscipline among pupils especially at the primary school levels of education is a universal challenge that is facing every school in all parts of the world.

In Italy, Emmanuel, Adom, Josephine and Solomon (2014) found that indiscipline is a multifaceted phenomenon regarding its displays and causes as well as its meanings, management and functions in the social, psychosocial and pedagogical fields. Pupils' discipline in schools is a product of various dynamics found within school and home microsystems. However, the place of peer counseling activities in enhancing pupils' discipline is yet to be fully brought into perspective.

Counseling have been conceived internationally in different ways. Peer counseling is a well-documented concept of counseling. As Stoops, Rafferty and John (2011) point out, it is a personal method of change

and is based on the idea that most people prefer to seek out their peers for help when experiencing challenges, frustrations, concerns and general problems. In other words, when pupils join schools for the first time, some of them experience emotional stress due to a change in the environment as well as behavioral and developmental gaps. As Patterson (2012) states, peer counseling is when students offer counseling services to their peers. Effective school counselors do not offer needs assessment, orientation, information and counseling services on their own. They made maximum use of peer helpers.

In a study carried out in Philadelphia, Leithwood and Jantzi (2006) noted that during the peer counseling or mentoring sessions, individual pupils offer their junior colleagues an opportunity for self-knowledge and self-development through individual or group interventions. Understanding and knowledge of oneself and the environment gained through counseling and mentoring leads to personal development and good decision-making. To corroborate these assertions, Smylie, Conley and Marks (2002), in a study conducted in Chicago, noted that senior pupils act as mentors who provide their young colleagues with a pool of knowledge that could be tapped on, to help polish their disciplinary, behavioral and some particular key skills that were said to be pertinent in career development. Smylie et al (2002) reported that senior pupils help their junior colleagues get involved searching or seeking out for good performers and requesting them to be mentors in given careers. This points to the fact that any junior pupil looking for a mentor is expected to seek out for positive and pleasing behavior patterns and personality, besides a mere successful track record.

Peer mentoring and counseling give pupils an opportunity to work on their issues and concerns without fear and intimidation. Smylie et al (2002) discovered that peer supervision increased in the peer counselors' empathy, respect, genuineness as well as concreteness. Through such skills, a pupil peer counselor is aligned to build a rapport with the peer they are counseling, making it easier to make an impact, and for the client to make sound decisions. This is consistent with the assertions of Bell (2002) who rated peer counseling as an outstanding tool that equips pupil peer counselors with counseling skills and techniques which makes it easier for them to reach their peers but also aid the pupil peer counselors themselves with life skills. Bell (2002) further noted that pupil peer concept provides a practical and economical means to meet the increasing needs of pupils in need of individual help.

In Sub-Saharan Africa, research has indicated that primary schools have embraced the concept of peer counseling as an effective form of counseling (World Bank, 2008). For example, in Botswana, after this realization, the University of Botswana introduced the peer counseling program spearheaded by pupils in 2003 which has produced positive results as reflected in the shared experiences of such pupils. Peer counselors unlike professional counselors are available to help their peers anytime and their counseling sessions are informal discussions and conversations which are not threatening. Peer counseling believes that peers have the ability to reach out and change each other since they understand one another better.

Cognizant of these viewpoints, Sithole (2008), in a study conducted in KwaZulu Natal Province in South Africa, posited that, to this end pupils are expected to build their own databases of prospective pupil mentors and design an action plan for connection. In Kenya and Mathioya Sub-county, cases of indiscipline among pupils in public primary schools pose a great a problem that has persisted over the years. Disruptive behavior problems such as not paying attention, bullying, stealing, violence, drug abuse, teasing other children, fighting, yelling and complaining in primary schools are of special concern to counseling



practitioners and researchers due to their association with later delinquency and school failure. To mitigate these challenges, peer counseling practices have been adopted where members of peer counselors act as peer mentors to new pupils, the peer mentees, in a particular subject, behavior pattern or lifestyle.

A study conducted in Mathioya Sub-county by Kindiki (2009) asserted that establishment of peer counselors was driven by the need of enhancing effective teaching and learning and an even more, the urgent need to tame school unrest within schools in Kenya. Kindiki (2009) noted that pupil leaders are a tremendous help to the school and play a particularly important role in mentoring younger pupils. However, Kindiki (2009) failed to articulate how different peer mentoring activities undertaken by peer counselors have improved school management. In other words, Kindiki (2009) failed to indicate how peer counselors mentoring programmes have impacted on managerial efficiency, pupils' performance and pupils' disciplinary patterns. In the same vein, it is not clear which particular skills members of peer counselors ought to possess in order to mentor their colleagues.

## 2.0 Methods and Procedures

The study adopted mixed methodology and thus applied concurrent triangulation research design.

Target population comprised of 58 deputy headteachers (47 male and 11 female) and 599 teachers (294 male and 305 female) all totaling to 657. A total of 196 respondents were selected. A questionnaire was used to collect data from teachers whereas an interview guide was used to collect data from deputy headteachers. Qualitative data were analyzed thematically along the objectives and presented in narrative forms whereas quantitative data were analyzed descriptively and inferentially using Pearson's Product Moment Correlation Analysis with the help of Statistical Package for Social Sciences (SPSS-Version 23) and presented using tables.

## 3.0 Results

The study sought to establish the extent to which teachers adopt peer counseling activities in public primary schools to promote pupils' discipline. Results are shown in Table 1;

**Table 1: Peer counseling activities and Pupils' Discipline**

			Pupils' discipline		Total
			Indisciplined	Disciplined	
Peer counseling activities	Less peer counseling activities	Count	16	51	67
		% within Peer counseling	23.9%	76.1%	100.0%
	Adequate peer counseling activities	Count	17	78	95
		% within Peer counseling	17.9%	82.1%	100.0%
Total			Count	129	162
			% within Peer counseling	79.6%	100.0%

Table 1 shows that schools with less peer counseling activities indicated 23.9% indiscipline cases among pupils while disciplined cases were 76.1%. Schools with adequate peer counseling activities had 17.9% cases of indiscipline and 82.1% cases of disciplined cases among pupils. This finding shows that adequate peer counseling activities among pupils reduces cases of indiscipline. Hypothesis was derived from the objective which stated: There is no statistically significant relationship between peer counseling activities and pupils' discipline in public primary schools in Mathioya Sub-county, Murang'a County, Kenya. Pearson Product Moment Correlation was used to test this hypothesis at 0.05 alpha level. Results are shown in Table 2.

**Table 2: Correlation between Peer Counseling Activities and Pupils' Discipline**

		Peer Counseling	Pupils' Discipline
Peer Counseling Activities	Pearson Correlation	1	.979**
	Sig. (2-tailed)		.001
	N	172	172
Pupils' Discipline	Pearson Correlation	.979**	1
	Sig. (2-tailed)	.001	
	N	162	162

\*\* . Correlation is significant at the 0.01 level (2-tailed).

Table 2 shows that there is a positive correlation between peer counseling activities and pupils' discipline,  $r = 0.979$ ,  $n = 172$ ,  $p = 0.001$ ." Since the  $p(0.001)$  is less than alpha value (0.05), the null hypothesis is rejected. Therefore, the test concludes that peer counseling activities positively influence discipline of pupils in public primary schools. This indicates that, in public primary schools where teachers engage in peer counseling activities to a less extent, have pupils manifest cases of indiscipline and thus such schools have many cases of indiscipline in a year. Thus, peer counselors develop friendships through their participation in mentoring programs and usually derive satisfaction from helping a younger pupil, and possibly shaping his or her life in a positive way. This indicates that pupil mentorship is therefore a one good road to decisiveness on career development with pupils.

The researcher also interviewed deputy headteachers who also responded in favor of the view that teachers rarely adopt peer counseling activities to enable pupils in primary schools share their personal experiences as a way of improving their adherence to rules and regulations. On further probing, one deputy headteacher, DHT1, observed,

*"Many teachers in my school have not opted for peer counseling among pupils. This is attributed to the fact that most of them lack idea of peer counseling activities and critical activities which need to be undertaken by the learners. This has not really helped in improving pupils' discipline such as adherence to school rules and regulations".*

These views further indicate that peer counseling has not been fully adopted in public primary schools as a strategy for improving pupils' discipline in public primary schools. The deputy headteachers further noted,

*“Teachers rarely create an opportunity for learners to share their personal experiences as a way of improving their discipline by reducing cases of violence, teenage pregnancies, bullying and fights among themselves”.*

This further indicates that peer counseling as an outstanding tool that equips pupil peer counselors with counseling skills and techniques which makes it easier for them to reach their peers but also aid the pupil peer counselors themselves with life skills. Hence, from these mixed findings, school management which engages pupils as peer counselors help their pupils perform better, adopt healthy behavior patterns, understand and accept themselves as well as the meaning of life relating it to their school career interests and satisfaction.

#### 4.0 Implications

The study recommends that teachers should partner with counsellors to train learners as peer counsellors which may enable them acquire basic skills to enable them help their colleagues with challenges of discipline. The Ministry of Education should ensure that every primary school has a trained teacher-counselor who is solely tasked to conduct counseling and modify pupils' behavior patterns. The Ministry of Education should also provide necessary materials and facilities such as counseling units in public primary schools.

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# **Soil chemical parameters and microbiological quality of biquinho pepper irrigated with treated wastewater in protected environment**

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**Abstract**

*The aim of this work was to evaluate the soil chemical parameters and microbiological quality of biquinho pepper fruits irrigated with treated wastewater and different irrigation depths. The experiment was carried out in protected environment with the application of four irrigation depths corresponding to 50, 75, 100 and 125% of the crop evapotranspiration with three concentrations of 0, 50 and 100% of treated wastewater in the cultivation of biquinho pepper in pots. The experimental design was in randomized blocks in a 3 x 4 factorial scheme, totaling 12 treatments, with three replications. The soil chemical parameters were determined before and after the growing the pepper with treated wastewater. Reference evapotranspiration (ET<sub>o</sub>) was estimated by the FAO Penman-Monteith method using data obtained from an Automatic Weather Station installed inside the protected environment. The microbiological quality was analyzed by quantifying fecal coliforms and the presence of *Salmonella* sp. recommended by Brazilian National Agency for Sanitary Surveillance (ANVISA). All pepper samples were in accordance with the limits recommended by the legislation and, therefore, the use of wastewater in pepper irrigation did not represent a risk to public health. The soil chemical parameters were changed in different ways after the application of the treated wastewater, being motivated by both soil and wastewater chemical characteristics.*

**Keywords:** *Salmonella*; fecal coliforms; evapotranspiration; ultisol; organic matter.

**1. Introduction**

In countries and regions with water scarcity, the reuse of wastewater is an alternative for replacing fresh water resources with wastewater for purposes that do not require drinking water quality (Helmecke, Fries,



and Schulte 2020).

The use of wastewater has become an interesting option as it reduces contamination by direct discharge of wastewater into water bodies, allows a more rational use of water resources and is an alternative source to make water available for agricultural crops (Cuba et al. 2015).

The need for reuse of wastewater for irrigation has become of paramount importance for countries with water scarcity (Tripathi et al. 2016). With the increase demand for irrigation water, the use of low quality water is an alternative to human coexistence in the semi-arid, reducing the demand for available water resources (Lucena et al. 2018).

Wastewater is used for crop irrigation as an alternative to better quality water. It has now become a common practice in many countries around the world to use wastewater for irrigation. Irrigation of crops with wastewater represents opportunities and challenges with regard to their uses and the environment, mitigating water deficit crises mainly in the semi-arid regions of the world (Khalid et al. 2018).

Several researchers (Aziz 2015; Demir and Sahin 2017; Disciglio et al. 2015; Gupta et al. 2019; Khalid et al. 2018; Khaliq et al. 2017; Libutti et al. 2018; Santos et al. 2018; Urbano et al. 2017; Yassin et al. 2017; Zeeshan and Shehzadi 2019) have carried out work with the use of wastewater in the irrigation of agricultural crops and the effect on soil chemical parameters.

With the occurrence of prolonged droughts in the Brazilian semiarid region, water scarcity has influenced agriculture in this region, so that the reuse of wastewater has become an alternative for pepper irrigation (Silva et al. 2019).

There is no record by agricultural production control agencies of an accurate estimate of pepper production in Brazil because most of the peppers are grown by small farmers from several Brazilian regions. There is a wide commercial acceptance of fresh or processed pepper fruits, covering also the marketing of ornamental plants and the manufacture of cosmetics and medicines (Ferraz et al. 2016).

The biquinho pepper is one of the most used varieties by small producers seeking high productivity, acceptance by the consumer market and good financial return, being attractive mainly for its mild taste and absence of pungency (Alves et al. 2016; Heinrich et al. 2015).

According to the above, this work aimed to evaluate the soil chemical parameters and the microbiological quality of the biquinho pepper fruits irrigated with treated wastewater and different irrigation depths.

## **2. Material and Methods**

The experiment was conducted in pots growing biquinho pepper (*Capsicum chinense*), belonging to the Solanaceae group, on a metal bench in protected environment. The treatments consisted of four irrigation depths corresponding to 75, 100, 125 and 150% crop evapotranspiration (ET<sub>c</sub>) with three concentrations of treated wastewater prepared with 0% treated wastewater, 50% supply system water plus 50% treated wastewater, and 100% treated wastewater. The experimental design was in randomized blocks, in the 3 x 4 factor scheme, with four repetitions, totaling 12 treatments.

Reference evapotranspiration (ET<sub>o</sub>) was estimated using the FAO 56 Penman-Monteith standard method using data obtained from an Automatic Weather Station installed inside the protected environment. The crop evapotranspiration obtained as a function of ET<sub>o</sub> and the crop coefficient values of the pepper grown

in protected environment of 0.74, 1.39, 1.17 and 1.02 (Santos et al. 2016).

The water supply was collected from a tap that was inside the protected environment and the treated wastewater was collected weekly from a Sewage Treatment Station, consisting of a pre-treatment unit with a grid and sand box and three treatment tanks, being anaerobic, aerobic and chemical. The collection was carried out in the aerobic tank, as the former contained a very high organic load that could cause damage to the crop and the latter tank contained chemicals.

The chemical parameters of the water supply system and treated wastewater can be seen in Table 1.

Table 1. Values of the chemical parameters of the water supply system and the treated wastewater

Chemical parameters	Water supply system	Treated wastewater
Total Phosphorus ( $\text{mg L}^{-1}$ )	<0.037	1.81
Carbonates ( $\text{mg L}^{-1}$ )	<5.22	<5.22
Bicarbonates ( $\text{mg L}^{-1}$ )	115.00	175.30
pH	7.24	7.46
Electrical Conductivity ( $\mu\text{S cm}^{-1}$ )	368.40	578.00
Total Dissolved Solids ( $\text{mg L}^{-1}$ )	206.30	374.60
Nitrate ( $\text{mg L}^{-1}$ )	9.8	2.23
Nitrite ( $\text{mg L}^{-1}$ )	<0.0009	0.26
Ammoniacal Nitrogen ( $\text{mg L}^{-1}$ )	0.12	3.72
Potassium ( $\text{mg L}^{-1}$ )	1.82	8.80
Calcium ( $\text{mg L}^{-1}$ )	57.09	49.01
Sodium ( $\text{mg L}^{-1}$ )	30.10	42.40
SAR	5.20	7.90
Magnesium ( $\text{mg L}^{-1}$ )	8.97	8.99
Sulfates ( $\text{mg L}^{-1}$ )	64.00	85.00
Chloredis ( $\text{mg L}^{-1}$ )	43.63	92.11

The sowing was done in Styrofoam trays filled with vegetable soil, which contained in its composition cattle manure and castor cake. Then the Styrofoam tray was taken to a greenhouse where it had a nebulizer to facilitate the germination of the seeds, which occurred 10 days after sowing, performing the thinning leaving only the most vigorous. The seedlings were transplanted into pots with a capacity of 21 L, each containing 15 kg of soil, classified as Ultisol.

The soil chemical parameters before the application of the treatments, with biquinho pepper crop irrigated with water from the supply system and treated wastewater can be seen in Table 2.

Table 2. Chemical parameters of the soil before application of the treatments, with beak pepper crop irrigated with water from the supply system and treated wastewater

Treatments	Soil chemical parameters									
	pH	OM	Na	K	Ca	Mg	P	CEC	V	EC
75% of ETc and 0% of TWW	6.2	8.9	56.2	120	4.1	1.8	66.4	8.0	79.7	1.1
75% of ETc and 50% of TWW	5.7	13.0	74.2	220	13.3	1.0	59.5	7.5	70.1	1.0
75% of ETc and 100% of TWW	6.6	31.0	87.0	196	5.4	1.1	19	9.0	81.8	1.0
100% of ETc and 0% of TWW	6.3	13.0	0.32	0.42	4.5	1.3	80.1	8.2	80.1	0.8
100% of ETc and 50% of TWW	6.6	12.2	0.25	118	3.5	0.8	17	6.1	76.4	1.0
100% of ETc and 100% of TWW	6.9	13.3	0.23	146	4.2	1.1	58.4	7.3	80.5	1.4
125% of ETc and 0% of TWW	6.4	9.3	0.29	109	3.4	1.2	45.1	6.8	76.1	1.2
125% of ETc and 50% of TWW	6.7	12.1	0.48	170	5.1	0.3	36.9	7.5	83.4	1.2
125% of ETc and 100% of TWW	7.1	13.6	0.24	151	3.5	1.0	59.6	5.1	100.0	0.9
150% of ETc and 0% of TWW	5.9	7.4	0.53	264	5.4	1.8	77.7	10.5	80.5	1.0
150% of ETc and 50% of TWW	6.5	12.4	0.83	267	4.5	2.0	54.2	9.5	85.0	1.0
150% of ETc and 100% of TWW	6.9	13.2	0.24	102	3.7	1.2	38.8	6.7	81.5	1.0

TWW – treated wastewater; ETc – crop evapotranspiration; OM – organic matter; Na – sodium; K – potassium; Ca – calcium; Mg – magnesium; P – phosphorus; CEC – cation exchange capacity; V – base saturation; EC – electrical conductivity.

The planting fertilization was performed at the time of transplantation for all pots and 1 g pot<sup>-1</sup> of urea (N), 4.2 g pot<sup>-1</sup> of phosphorus (P<sub>2</sub>O<sub>5</sub>) and 1.5 g pot<sup>-1</sup> of potassium chloride (K<sub>2</sub>O) were applied. Until the stability of the crop, only drinking water was used, thus inserting the treated wastewater from the second phenological phase of the crop.

For cover fertilization 0.5 g pot<sup>-1</sup> of urea and 0.75 g pot<sup>-1</sup> of potassium chloride were applied 30 days after transplanting in the treatments that were irrigated with 100% water from the supply company.

For microbiological quality, fecal coliforms and Salmonella analyses were performed according to the method described by APHA (2001) and the microbiological standards established for fresh vegetables in Resolution RDC n° 12/01 of the Brazilian National Agency for Sanitary Surveillance (ANVISA), were adopted as the reference.

### 3. Results and Discussion

Microbiological analysis of biquinho peppers was performed to verify whether or not they were contaminated by supply water and treated wastewater (Table 3), based on the analyses recommended by RDC 12/01, which allows up to 102 MPN g<sup>-1</sup> for fecal coliforms and requires absence of Salmonella sp. It can be observed that fecal coliforms and Salmonella were not found in the analyzed peppers for all treatments, indicating that all samples were compliant with the legal patterns (Table 3).

Table 3. Microbiological quality of the beak peppers irrigated with supply water and treated wastewater

Treatment	Fecal coliforms (NMP g <sup>-1</sup> )	<i>Salmonella sp</i>
75% of ETc and 0% of treated wastewater	< 3	Absence
75% of ETc and 50% of treated wastewater	< 3	Absence
75% of ETc and 100% of treated wastewater	< 3	Absence
100% of ETc and 0% of treated wastewater	< 3	Absence
100% of ETc and 50% of treated wastewater	< 3	Absence
100% of ETc and 100% of treated wastewater	< 3	Absence
125% of ETc and 0% of treated wastewater	< 3	Absence
125% of ETc and 50% of treated wastewater	< 3	Absence
125% of ETc and 100% of treated wastewater	< 3	Absence
150% of ETc and 0% of treated wastewater	< 3	Absence
150% of ETc and 50% of treated wastewater	< 3	Absence
150% of ETc and 100% of treated wastewater	< 3	Absence

ETc – crop evapotranspiration

These results were similar to those reported by Gomes Filho et al. (2020a) and Gomes Filho et al. (2020b) when they analyzed lettuce and beans irrigated with treated wastewater. As well as the ones found by Batista et al. (2017), who evaluated the microbiological quality of papaya fruit produced with treated wastewater. Libutti et al. (2018) reported that the fecal coliforms populations in tomato and broccoli were not influenced by the types of water used for irrigation. The authors described that the drip irrigation system used, which avoided close contact between the water and the plant, may have contributed to these results. As found in this research, that also applied water near the root system of the crop, without direct contact with the leaves and fruit.

According to Alves et al. (2017), the microbiological quality of bananas irrigated with treated wastewater was similar to those irrigated with supply water and mineral fertilizers, however, the effects of irrigation using treated wastewater should be monitored to ensure that they do not compromise the quality of the final product or consumer acceptance.

Based on the values of the soil chemical parameters evaluated before (Table 2) and after (Table 4) the application of the treatments, it was observed that some parameters had positive variation (elevation of pH, EC, and V), negative variation (decrease of K and Na) and others with positive and negative variations (organic matter, Ca, Mg and CEC). The values of Aluminum were constant and equal to 0.08 cmolc dm<sup>-3</sup> before and after the cultivation irrigated with treated wastewater (Table 4).

It was found that the pH values of the soil increased in all treatments, probably due to base dispersion during cultivation and dissolution by irrigation, since the water used in irrigation had alkaline pH and high levels of bicarbonates and calcium when TWW was absent (Table 1). When the TWW is present, this should probably also be attributed to the pH of both the irrigation water and the TWW itself, whose high levels of calcium and sodium, in addition to chlorides, caused an increase in their respective values in the soil. This resulted in the increase in the values of sodium, potassium, calcium, phosphorous and magnesium contents

(Tables 2 and 4). Research conducted using agro-industrial wastewater in tomato cultivation has provided a slightly increase in soil pH (8.2) with respect to the initial value (7.9) probably due to the accumulation in the soil of basic cations due to the fertilising (Disciglio et al. 2015).

The high levels of salts in the soil, expressed by sodium, influenced the values of EC (Table 4), markedly in the treatment corresponding to 75% of the ETc, which can be attributed to the effects of this water (Table 1) on the soil, because it has high levels of salts and bases, contributing to the elevation of such parameters. The average values of EC in all treatments after the application of TWW (Table 4), it indicated moderate risk regarding soil salinization (Ayers and Westcot 1991). Abd-Elwahed (2018) observed that huge volumes of wastewater applied over the long term increased salinity, negatively affecting soil quality. Heras and Mañas (2020), studying the effect of wastewater on the chemical parameters of soil cultivated with olive groves and vineyards irrigated with treated wastewater, found high values of electrical conductivity in the soil.

As the pH values of both the water used for irrigation and the TWW are in the alkalinity range (Table 1), consequently the values of the aluminum contents (Table 4) were low, as they were displaced from the sorbent complex, occupied not only by the bases, but predominantly by salts, so much so that the electrical conductivity of the soil in all the treatments rose because of this behavior, after the addition of irrigation water raised the values, with greater differences when adding TWW (Tables 2 and 4), as well as for base saturation (V%).

It was observed that the sodium values showed higher decreases in treatments with lower doses of TWW combined with higher levels of available water in the soil (Table 4). This is explained by the higher water leaching capacity in this condition and associated with lower doses of TWW containing 42.4 mg L<sup>-1</sup> of sodium (Table 1), reducing the soil content and cause larger reductions proportionally at the end of the research. Urbano et al. (2015) observed that the concentration of nutrients in the soil increased, including sodium, after the passage of domestic sewage reuse water through Oxisol, in the lettuce crop, with a tendency to salinate, but there was no damage to the physical properties of the soil. However, Medeiros et al. (2011) observed that sodium contents increased in all soil layers (0 to 1.0 m, evaluated every 0.2 m), in all different swine effluent dosages, but the highest contents were verified in the areas that received treated effluent, behavior contrary to that obtained in the present study, indicating in this case, lower propensity to soil salinization. Excess sodium in soils causes harmful physical conditions for growth and, mainly, for the development of the root system, because in low concentration sodium acts as dispersant and in high concentration as a binder, destroying the soil structure. Generally, sodium soils, which have a high sodium content, cause the reduction of nitrogen mineralization, directly affecting plant growth (Dias and Blanco 2010). Thus, crops can be directly affected when high concentration sodium in irrigation water becomes a toxic element for the plant and indirectly when it causes unfavorable physical conditions for the development of the root system (Oliveira et al. 2013).

It was also observed that for the pH range of the values obtained in the soil there was an increase in the organic matter contents in the soil, due to two conjugated factors. The first factor is the TWW as source of organic matter and its preservation in the soil due to the pH range of the soil (Table 1), the irrigation water and the TWW, corresponding to alkalinity, a situation that preserves more this organic matter, since in this condition, there is less biological activity resulting in less oxidation of these organic sources, contributing

to the elevation of the contents (Tables 2 and 4). This organic matter, due to its high specific surface, works as adsorption sites, not only of salts, but other chemical elements, decreasing their leaching to deeper layers of the soil, contributing to the maintenance of higher levels of Mg, P and Ca, resulting in higher values of CEC and V% (Tables 2 and 4).

The increase in organic matter content may have been derived from the contribution of TWW, as it has a total dissolved solids content of  $374.60 \text{ mg L}^{-1}$ , an aspect that contributes to the increase in content, which associated with higher levels of available soil water, by decreasing the proportion of air in the soil, decreasing biological activity and processes related to decomposition and oxidation of organic matter, resulting in smaller reductions, even at higher concentrations of TWW added to the soil (Table 4).

Finocchiaro and Kremer (2010) observed an inverse relationship between soil microbial activity and the deposition of treated wastewater effluent when compared to river water although they observed that the wastewater had twice the electrical conductivity and four times the sodium concentration compared to river water. In this study the average electrical conductivity obtained was around  $2.2 \text{ dS m}^{-1}$  at the end of the experiment, a condition that would stimulate soil microbial activity.

The increase of phosphorus contents in all treatments is probably due to the greater solubilization of this chemical element with the irrigation water, so much so that higher final contents of this element were observed in the soil for the largest irrigation depths, being potentialized by the addition of TWW, since this material is the source of this element. Although phosphorus has low mobility in the soil, irrigation results in greater solubility because of the greater availability of water and a high soil infiltration rate, which favored its release and coupled with low mobility in the soil profile, resulted in the end in greater concentration.

Belaqziz et al. (2016), investigating the effect of direct amendment of olive mill wastewater, observed an important increase in soil chemical parameters, namely electric conductivity (EC), phosphorus, sodium and organic matter. Yassin et al. (2017) found that the mean levels of P in the soil showed an increasing trend towards the end of growing season with the highest concentrations in the soil irrigated with treated wastewater.

## **4. Conclusions**

All the fruits samples were in accordance with the parameters officially established by Brazilian Health Regulatory Agency, as well as that treated wastewater may potentially be used as alternative irrigation water without deleteriously affecting the microbiological safety of biquinho pepper.

The soil chemical parameters were changed in different ways after the application of the treated wastewater, being motivated by both soil and wastewater chemical characteristics.

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# RELATIONSHIP BETWEEN PSYCHOLOGICAL CAPITAL AND MOTIVATION: STUDY IN HEALTH ORGANIZATIONS OF SOUTHERN BRAZIL

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## ABSTRACT

**Purpose:** *The psychological capital and the self-determination theory are areas related to the research of human behavior in organizations. This study had as objective to verify if there are relations between the categories of Motivation with the dimensions of Psychological Capital.*

**Design/methodology/ approach:** *it was performed a quantitative empirical study. The sample consisted of 235 workers working in the health sector, in south of Brazil. Data collection was obtained through the application of PCQ-24 and MWMS.*

**Findings:** *There is a negative correlation between psychological capital and demotivation as well as a positive correlation between psychological capital and intrinsic motivation. It was observed that the higher level of psycap more the results approached the intrinsic motivation. The results suggest that care professionals have higher levels of motivation for work and psycap than those in administrative area. Likewise, people with a complete undergraduate level had high levels of Motivation and Psychological Capital. In sum, the results suggest that Psycap is an important contribution to motivation at work.*

**Research limitations/implications:** *This empirical research was performed only with a sample of health workers from Brazil. For this reason the results can not be generalized.*

**Practical Implications:** *It is possible to verify the level of Motivation and Psychological Capital of the workers, being able to develop strategies to develop skills that promote better organizational performance.*

**Originality/value:** *It has conducted a research with two instruments still little used in the Brazilian context - PCQ-24 and MWMS - relating these two approaches in a health sample.*

**Keywords:** Psychological Capital. Motivation. Self-determination Theory. Health organizations, PCQ-24.

## INTRODUCTION

The globalized market has brought to the organizational world a greater complexity and speed in their relations. Turbulent environments, global competition, business mergers, and continual changes

pressure organizations to seek rapid adaptations, demanding an increasing effort from their employees, compromising individuals' physical and emotional health (Capra, 2002).

In this uncertain and constantly changing context, a group of researchers drew attention to the excessive number of papers and academic research that focus on the diseases, weaknesses and problems of individuals (Myers, 2000).

In the search for new scientific paradigms, Luthans' studies on Positive Organizational Behavior pointed a promising path. Luthans and colleagues (2002), based on the Positive Psychology of Seligman and Csikszentmihalyi (2000, 2014) and on the challenge launched by Seligman himself in 1998 - which was to rescue the studies of Psychology for the potentialities and virtues of individuals – focused their research on the behavior and positive capacities of workers, valuing their contributions, their skills and their relevance in achieving organizational results.

In another context, but also with a concern to rescue the importance of people in the results of companies, Gagné and colleagues (2015) spent their efforts in validating an instrument that measures the degree of motivation of people at work.

This study turned to these two approaches, Psychological Capital and Motivation for work. These approaches contemplate in their theoretical foundations the dimension of human subjectivity, repositioning people as a central theme in research on effective companies.

The Psychological Capital and Work Motivation studies focus on understanding the influence of human behavior in the organizational context (Choi & Lee, 2014). The construct Positive Psychological Capital, or simply Pscap, was developed by Fred Luthans and collaborators, starting in the year 2002. Its dimensions, Self-efficacy, Hope, Optimism and Resilience are combined capabilities that enable individuals to mobilize their psychological resources to an effective result in their work (Luthans & Youssef, 2004).

The Self-Determination Theory (SDT) defines Motivation as an internal psychological process that receives influences from personal needs and interactions with the environment. In other words, it is the relation between the satisfaction of basic needs (autonomy, competence and bond) and the energy used to achieve it (Gagné & Deci, 2005). The purpose of the Self-Determination Theory (Ryan & Deci, 2000a) is to study the motives that drive people to act. The SDT (Self-Determination Theory) explains the relationship between Extrinsic Motivation and Intrinsic Motivation, proposing that it is possible to promote situations that mobilize individuals to transform an External Motivation into an Internal Motivation.

Both the Psychological Capital approach and Motivation for work, investigate the behavior of individuals in organizations from the perspective of their subjectivity. Its seminal authors, Luthans and Gagné (respectively), position people as a fundamental strategic differential. Its objectives are to evaluate the impact of the behavior of the subjects in the performance of the organizations, both in the aspect of the accomplishment of the tasks, as in the commitment with the company. Both currents believe that these personality states are not immutable, that is, they can be apprehended and developed (Gagné, Forest, Vansteenkiste, Crevier-Braud, Van den Broeck, Aspel & Halvari, 2015, Luthans, Youssef-Morgan & Avolio, 2015 ).

Faced with this, the study of these two themes (Psychological Capital and Motivation) highlights the importance of organizations to potentialize and optimize their human resources to achieve a competitive



advantage by increasing the positive capabilities of their employees with consequent increase in functional impairment, satisfaction at work, well-being and creativity (Millette & Gagné, 2008, Rego, Sousa, Marques & Cunha, 2012, Choi & Lee 2014, Luthans & Frey, 2017).

However, when studying these two distinct areas, in the context of human behavior at work, it is perceived that some concepts seem to deal with phenomena similar or complementary to each other. For the authors Verleysen, Lambrechts & Van Acker (2015) there is synergy between these two theoretical approaches revealing a complementary relationship between them. From this, this study had as objective to verify if there are relations between the categories of Demotivation, Extrinsic Motivation and Intrinsic Motivation with the dimensions of Psychological Capital (Self-efficacy, Hope, Optimism and Resilience). For that, an empirical research was carried out with 235 health professionals from the South of Brazil, both in the administrative and care areas. Data collection was obtained by applying the PCQ-24 and MWMS instruments. The results were analyzed through statistical tools, indicating that there is a positive relationship between the dimensions of Psychological Capital and Intrinsic Motivation and a negative relation with the Demotivation dimension. The results, discussion and considerations will be presented in the following sections.

## **THEORETICAL FRAMEWORK**

### **PSYCHOLOGICAL CAPITAL**

Psychological Capital (Psycap) is the central construct of Positive Organizational Behavior (COP), which has its theoretical origins based on Positive Psychology, developed by Seligman and Csikszentmihalyi (2000, 2014). This stream of studies directs the look at the strengths of the people and their positive capacities.

The choice of the word "capital" in this construct is intended to reinforce the idea that people are valuable human resources for organizations. Therefore, the word "Psychological Capital" suggests, for management, that, by investing in people, companies will be 'capitalizing' on their resources, increasing their assets, gaining a unique competitive advantage (Luthans & Youssef, 2004).

Thus, Psycap is defined as a 'state' of positive psychological development, characterized by the individual having a set of attributes: self-efficacy: being confident and self-efficacious, in order to maintain the effort required to succeed in challenging tasks; optimism: make positive attributions about present and future events; hope: persevere in relation to the objectives and, if necessary, redirect the ways to reach the goals to be successful; resilience: to overcome and return to normal emotional state in the face of problems and adversities (Luthans & Youssef, 2007).

Faced with this, Hope, Self Efficacy, Resilience and Optimism, or simply HERO, operate synergistically, becoming a unique component. They act in an integrated and interactive way in the motivational search for expected organizational results (Luthans, Avey & Patera, 2008). The four dimensions combined increase the probability of success in individuals' actions, being associated with greater effort, motivation and perseverance in performance within companies (Avey, Luthans, Smith & Palmer, 2010). Each dimension has been selected from the empirical studies of clinical psychology because they have unique characteristics such as: (a) being a psychologically positive capacity, (b) being a theory

with validation in scientific research, possible to measure and (c) be a state-like, open to change and development that has a positive impact on attitudes, behaviors, performance and well-being at work (Luthans & Youssef, 2004, Youssef & Luthans, 2007, Luthans & Youssef-Luthans & Youssef, 2004, Luthans & Yousset-Morgan, 2015).

Hope can be defined as the ability and determination to pursue a goal (willpower) and the ability to formulate effective plans for achieving it (waypower), even when it is necessary to change routes and create new paths to reach the goal, maintaining motivation (Luthans, 2002, Youssef & Luthans, 2007, Snyder & Lopez, 2009). Self-efficacy represents the individual's belief in being able to mobilize, through motivational and cognitive resources, the actions necessary to successfully execute a specific task in a given context (Bandura, 1977, Luthans, 2002). Resilience, on the other hand, is a set of phenomena that allow individuals to react to situations of risk and adversity assertively and satisfactorily. This characteristic allows the subject to quickly recover from issues that compromise their development, being a positive adaptive system in the face of dramatic changes and failures (Masten, 2007).

Optimism, however, concerns individuals' belief that good things will happen to them (Luthans, Avey & Patera, 2008). It is linked to the form of stress coping, goal orientation, and orientation to the present and future (Carver, Scheie & Segerstrom, 2010).

## MOTIVATION

The concern of the managers with the motivation of their employees is a frequent theme in the Administration area. This is because motivation is associated with good performance, jobless satisfaction, and commitment of employees to organizational goals. But, despite its relevance to management, there is no consensus on this concept (Borges & Filho Alves, 2001).

The Self-Determination Theory defines Motivation as "being moved to do something" (Ryan & Deci, 2000a). This approach argues that individuals have a sense of will and initiative to make decisions. In this way, it postulates that the subjects' actions are oriented by internal issues, external issues and by the use of reason (cognition). For the seminal authors of this theory, Ryan and Deci, a motivated person is who has the energy to perform an activity to the end. They point out that there are different types and levels of motivation. This (the motivation) will be of one nature or another, according to the relation with the personal goals and reasons that the individual has to act.

From this analysis, emerges the theoretical understanding that motivated behavior must be analyzed with a focus on the quality, quantity and intensity of its reasons and actions. Thus, the Self-Determination Theory (SDT) bases its studies on the understanding of motivation in the three focuses (quality, quantity and intensity) and its relations with Intrinsic Motivation and Extrinsic Motivation (Ryan & Deci, 2000b).

According to Gagné and Deci (2005), in Self-Determination Theory (SDT) there are six levels of motivation that go from the Demotivation that represents total absence of motivation and intentionality, with four intermediate levels of Extrinsic Motivation and finally the Intrinsic Motivation, in which the activity is carried out with complete personal intentionality, for pleasure and self-desire.

Figure 1 shows the theoretical framework of Motivation, according to the vision of SDT, which is classified in the three groups and 6 levels: Demotivation, Extrinsic Motivation and Intrinsic Motivation.

Figure 1 – *Continuum of Self-determination*

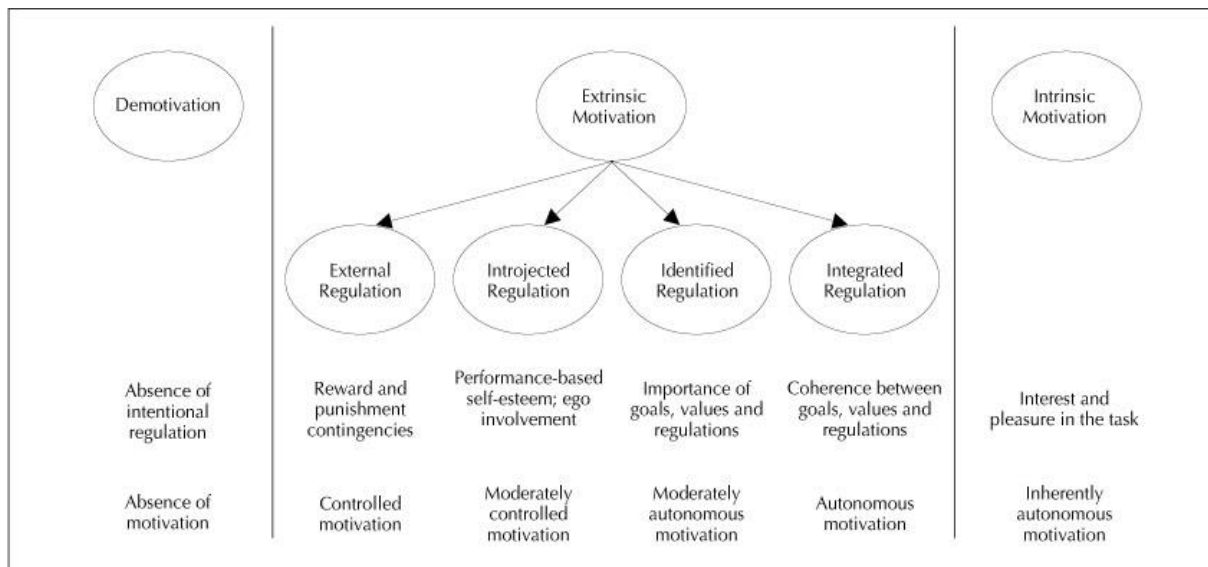


Figure 1 The Self-Determination continuum

Source: Adapted from Gagné and Deci (2005, p. 336).

Demotivation is the absence of motive. The individual has no intention for action, that is, the activity is completely devalued without any personal control for accomplishment.

Extrinsic Motivation is divided into four groups of behavior regulation: a) external regulation: It is the least autonomous form of motivations in which the subject seeks reward or avoid punishment; b) introjected regulation: Actions are performed to avoid negative feelings (guilt or anxiety) and have the expectation of self-approval; c) identified regulation: the action is identified with personal goals. The subject acts to achieve a future goal. There is a conscious appreciation even if the task is not pleasurable; d) integrated regulation: There is consistency between personal goals, values and the action taken. Congruent with the self is the most autonomous form of Extrinsic Motivation. However, behavior is aimed at achieving personal benefits.

Intrinsic Motivation is autonomous motivation by definition. Activity is seen as an end in itself, being carried out with great interest and pleasure (Guntert, 2015, Gagné et al., 2015).

Gagné et al. (2015) highlight that Extrinsic Motivation refers to engaging in activities for instrumental reasons, that is, to avoid punishment or criticism, to receive approval and reinforcement, to increase self-esteem or to achieve a goal of personal worth. However, the possibility of individual effort in transforming this External Motivation into internal (Intrinsic) Motivation places the subject in a position to reorient the path and energy to achieve their personal objectives and goals.

This new postulate places Extrinsic Motivation and Intrinsic Motivation as a continuum, varying in degree and intentionality. In addition to not having a clear boundary between the levels of Motivation, research has proven the possibility of making Intrinsic an Extrinsic Motivation (Van den Broeck, De

Cuyper, De Witte, & Vansteenkiste, 2010; Gagné et al., 2015). This finding has great value for the management area, because through this possibility, organizations can promote situations that help people to motivate themselves to work, resulting in better organizational performance.

#### THEORETICAL RELATIONS BETWEEN PSYCAP AND SDT

As the proposal of this work was to verify if there is a relation of these two approaches, it was necessary to rethink common points that they explore. Therefore, based on the readings made of these two distinct theoretical currents, it is verified that both propose to study the organizational behavior of the individuals, with orientation to the organizational performance (Youseff-Morgan 2014; Gagné & Deci, 2005). Another important factor is that the two approaches have been devoted to developing measurement tools, based on scientific rigor. In the studies of Psychological Capital we have the scale PCQ-24 and in the SDT scale MWMS.

Research topics can also be listed as a point of convergence between theories. The subjects covered are: performance at work, commitment, well-being, intention to leave, stress among others (Avey, Luthans & Jensen, 2009, Luthans et al., 2010, Sun et al., 2012; Fernet et al., Gillette et al., 2013, Gillette et al., 2013).

However, it is in relation to theoretical constructions that we find signs of confluence. In the definitions of Positive Organizational Behavior (POB), the term 'motivation' is widely used. In justifying the importance of POB studies, Youssef-Morgan (2014) points out that the underlying theoretical mechanism, connecting the four constituent dimensions of PsyCap, is based on motivated and persevering effort to achieve success. This statement was originally put by Luthans et al. (2007 p.550), when he explained why some people react to situations through Self-Efficacy, Hope, Optimism and Resilience. In the original the quotation is as follows: "[...] positive appreciation of circumstances and probability of success based on motivated effort and perseverance."

In the original concepts of the four dimensions of Psychological Capital, and especially in Self-Efficacy and Hope, the word 'motivation' is found to compose its definitions. This question demonstrates the importance of this presupposition (motivation) for the psychological resource to manifest itself in the actions of individuals.

By contrast, in Self-Determination Theory, Ryan and Deci (2000b) clarify that the basic needs of individuals (autonomy, competence and bond) are inherent in human nature. The authors state that individuals strive to meet these needs. In this movement, they boost psychological growth, promoting the 'positive' development of people. According to his words, Ryan and Deci (2000b) state that satisfying basic needs promotes psychological development and the full realization of human potential. In this context it can be related that the personal characteristics of the subjects are representing the COP concept of positive psychological states.

Another possible analogy is between the Necessity for Competence and Self-Efficacy. According to Gagné and Deci (2005), Necessity of Competence means recognizing in oneself the ability to accomplish something. This concept resembles that of Self-efficacy, which is confidence in one's own ability to accomplish something (Luthans, 2002).

In empirical studies, relating SDT and work, the concept of 'psychological resources' is explored. In the context of Self-Determination Theory, psychological resources are defined as an individual's ability

to satisfy their basic needs (autonomy, competence, and bonding). However, it is expressed that some people seek more or less hard to reach their personal goals, transposing the mishaps and remaining perseverant (Fernet et al., 2014, Trepanier, Fernet, Austin, 2013, Guntert, 2014). This statement may also lead to the understanding that these internal psychological resources are similar to the Psycap definition (Resilience, Hope, Self-Efficacy, and Optimism).

The authors Gagné de Deci (2005) conceptualize motivation as a relation between the satisfaction of basic needs (autonomy, competence and bond) and the energy employed to reach them. The word 'energy' also opens the authors' comments to state that some people mobilize more energy than others to meet these needs. It conveys the same idea of the authors, mentioned above, on the similarities with the positive psychological states defended by the theory of Psycap.

Taking into account these possible similarities, the following sessions will present the steps of the quantitative research, with the statistical correlations found.

## SAMPLE AND PROCEDURES

Data from the survey were collected from 249 participants, of whom 101 responded to the instrument in a physical document (printed) and 139 people answered the instrument online. Of this total, 235 valid questionnaires (n = 235) were considered for data analysis.

It is worth mentioning that the respondents were professionals working in public or private health services, such as hospitals, BHU (Basic Health Units) and medical care clinics in south of Brazil. Public health services are those that are administered wholly by the government; private institutions are that have administration and financial resources from the civil initiative, non-public and mixed health are organizations that have private administration with public budget participation.

The sample was health' professionals who performed administrative or care functions. By 'care functions' is meant all employees who works with the patient directly interfering with the treatment. Examples of care functions are Physicians, Nurses, Nutritionists, Pharmacists, Psychologists, Physiotherapists, Nursing Technicians, Technicians in Radiology, Technicians in Collection, among others.

By 'administrative' it is understood the professionals that acted with activities indirect to the care functions but that complement the health service. Examples of these administrative functions are the professionals who works in the following areas: Direction, Human Resources, Financial, Finance, Reception, Laboratory, Internal Pharmacy, Supplies, Purchasing, Maintenance, Hygiene, Kitchen and Hospital Nutrition, among others.

## MEASURES

For the data collection in the quantitative stage, an instrument was used that brings together MWMS and PCQ - 24, also containing demographic questions. The MWMS and the PCQ - 24 are scales used to know the Motivation for work and the Psychological Capital of the employees of the organizations.

Thus, PsyCap was measured using the Psychological Capital Questionnaire (PCQ - 24) which contains 24 questions distributed in: six items that measure Self - efficacy, six items that measure Hope,

six items that measure Optimism, and six items that measure Resilience (Luthans et al., 2007). To use this scale, permission was received from Mind Garden, the legal copyright holder.

Motivation was measured using the Multidimensional Work Motivation Scale (MWMS, Gagné et al., 2015), which comprises nineteen (19) questions in which the individual should answer the questions considering the following observation: "Why do you strive or would strive in your current job?" The answers are organized on a likert scale of 07 points where 01 means 'nothing' and '07' completely.

Both instruments were translated from English to Portuguese (Brazil) through the reverse translation technique.

## RESULTS AND DISCUSSION

The descriptive analysis and the Cronbach's  $\alpha$  were initially performed for the dimensions of this study, the results of which are shown in Table 1.

Table 1 – Descriptive Analysis

	Theoretical Dimension	M	SD	Cronbach's $\alpha$
<b>Motivation</b>	Demotivation	1,21	0,42	0,79
	External Regulation (Social)	3,76	1,79	0,90
	Injected External Regulation (Material)	3,25	1,70	0,83
	Identified External Regulation	4,93	1,57	0,84
	Integrated External Motivation / Intrinsic Motivation	5,68	1,24	0,92
<b>Psycap</b>	Efficiency	5,66	1,04	0,92
	Hope	5,47	1	0,9
	Optimism	5,38	1,07	0,84
	Resilience	5,28	1,12	0,82

Next, the analysis was performed considering the segmentation of the sample, through the demographic data of this study, the t-test was performed for independent samples. The purpose of this verification was to understand if the results found, organized by demographic categories (gender, age, function, schooling and company time) are by chance or result from significant differences. The criterion used was to consider, for levels of significance of assumed equal variances, that the test results  $t > 0.05$  result in differences that are due to chance, that is, it has no statistical significance (Malhotra, 2012).

From this analysis, it was verified that the gender category was the only one that did not present significant differences in their responses. In this way it is possible to conclude that the masculine gender and the feminine gender do not influence the Psychological Capital and the Motivation for the work.

The age category presents significant difference only when related to the External Motivated Introjected (material) factor. The values found up to 35 years are 4.02 and over 35 years, worth 3.44. These results suggest that people up to age 35 believe that work effort will result in more external rewards such



as financial gains, stabilities, and promotions. This type of effort is characterized by the dimension Extrinsic Introjected Motivation, which is one of the forms with less autonomy of motivation (Gagné et al., 2015).

In other words, people over 36 years old, within the concept of a continuum explored by Gagné et al. (2015), are subject to motivations that are also of an Extrinsic nature, but that align the motives to act identified with personal expectations of performance at work.

For the analysis comparing the data referring to the function, two groups are distributed: care professionals and administration professionals. Evaluating from the t-test it can be concluded that there are differences in the responses of these groups regarding the dimensions of Demotivation, Intrinsic Motivation / Integrated External Regulation and Hope. The indices can be checked in Table 2 below:

Table 2 – Function and Teste *t*

Dimensions	Function	N	Mean	Std. Deviation	Std. Error	Significance t-test
Intrinsic Motivation and Integrated External Motivation	Administrative	116	5,41	1,48	0,14	0,001
	Assistance	119	5,95	0,87	0,08	
Identified External Regulation	Administrative	116	4,80	1,59	0,15	0,214
	Assistance	119	5,06	1,55	0,14	
Injected External Regulation (Material)	Administrative	116	3,28	1,82	0,17	0,797
	Assistance	119	3,22	1,76	0,16	
External Regulation (Social)	Administrative	116	3,80	1,69	0,16	0,733
	Assistance	119	3,72	1,72	0,16	
Demotivation	Administrative	116	1,30	0,48	0,04	0,003
	Assistance	119	1,13	0,33	0,03	
Psychological Capital Efficiency	Administrative	116	5,50	1,22	0,11	0,020
	Assistance	119	5,81	0,81	0,07	
Psychological Capital Hope	Administrative	116	5,26	1,16	0,11	0,002
	Assistance	119	5,67	0,79	0,07	
Psychological Capital Resilience	Administrative	116	5,21	1,24	0,12	0,365
	Assistance	119	5,35	1,00	0,09	
Psychological Capital Optimism	Administrative	116	5,28	1,20	0,11	0,142
	Assistance	119	5,48	0,92	0,08	

These results reveal that the professionals who work in the care function have greater Intrinsic Motivation / Integrated External Motivation and a lower rate of Motivation in work. In other words, the employees of the administrative function tend to present greater Job Demotivation and greater need for External Motivations to carry out their work activities.

In this item function, the analysis of Psychological Capital portrays significant difference only in the dimension Hope. Respondents who carry out activities in the care function present greater capacity in this factor than those of the administrative function. Care professionals tend to have clearer goals and objectives in their work, finding alternative ways to perform their tasks, using their cognitive and affective skills in the execution of their tasks (Snyder & Lopez, 2009).

Regarding company time, it can be concluded from the t-test that there is a significant difference only in the Dimension of Psychological Capital Effectiveness. The indices can be found in Table 3.

Table 3 – Company Time

Dimensions	Company Time	N	Mean	Std. Deviation	Std. Error	Significance t-test
Intrinsic Motivation and Integrated External Motivation	Less 3 years	99	5,58	1,36	0,14	0,27
	More 3 years	136	5,76	1,14	0,10	
Identified External Regulation	Less 3 years	99	4,93	1,65	0,17	0,99
	More 3 years	136	4,93	1,52	0,13	
Injected External Regulation (Material)	Less 3 years	99	3,45	1,85	0,19	0,14
	More 3 years	136	3,10	1,73	0,15	
External Regulation (Social)	Less 3 years	99	3,98	1,69	0,17	0,10
	More 3 years	136	3,60	1,70	0,15	
Demotivation	Less 3 years	99	1,24	0,45	0,05	0,38
	More 3 years	136	1,19	0,39	0,03	
Psychological Capital Efficiency	Less 3 years	99	5,47	1,09	0,11	0,02
	More 3 years	136	5,79	0,99	0,09	
Psychological Capital Hope	Less 3 years	99	5,39	1,06	0,11	0,33
	More 3 years	136	5,52	0,97	0,08	
Psychological Capital Resilience	Less 3 years	99	5,21	1,25	0,13	0,41
	More 3 years	136	5,33	1,03	0,09	
Psychological Capital Optimism	Less 3 years	99	5,36	1,17	0,12	0,82
	More 3 years	136	5,40	1,00	0,09	

These results suggest that people with less company time (less than 3 years) have less confidence in the performance of their duties, needing more assistance in the execution of their work tasks. On the other hand, workers with more than three years of work demonstrate that they have the belief in their

personal capacities, mobilizing cognitive and emotional resources to carry out the tasks of their work successfully.

In relation to the data 'Degree of instruction', this showed the greatest significant differences among the respondents. In the Motivation for Work factors, measured by the MWMS, all dimensions have significant difference with the exception of Social Extrinsic Motivation (without relevant meaning). The results show that people with a higher level of education have higher motivation and less demotivation at work than individuals without undergraduate courses. Likewise, as far as Psychological Capital dimensions are concerned, all respondents with higher levels of education have higher levels of Psycap. The dimensions Efficacy and Optimism appear with the greatest differences between these two categories, indicating a possible interpretation that individuals with higher education develop the positive capacities of behavior at work.

According to Youssef and Luthans (2007), the positive capacities of individuals are 'states' of personality. This condition of 'state' allows people to develop them from their experiences, self-reflection, and the intention of self-improvement. Reflecting on these authors' positions it is possible to suggest that formal education, through the undergraduate course, promotes the development of Psychological Capital in subjects.

One result that caught the attention of the researchers refers to the relationship between the Resilience dimension and schooling. Non-graduate students had an average of 4.88 in this factor that indicates most of the answers as 'I do not agree or disagree'. Considering that the results above score 5 are indicators of positive psychological ability, this result of 4.88 - although very close to 5 - may indicate that ungraded people tend to have difficulty recovering from adverse situations at work, adapt to change. Individuals with Resilience ability have flexibility in solving problems and effective and positive improvisation in times of uncertainty (Luthans, 2002; Youssef & Luthans, 2007).

The results of this research suggest that professionals without complete graduation do not have this capacity developed, indicating a very significant difference in relation to subjects with higher schooling. These results can be verified through Table 4.

Table 4 – Degree of Instrution

Dimensions	'Degree of instruction'	N	Mean	Std. Deviation	Std. Error	Significance t-test
Intrinsic Motivation and Integrated External Motivation	Non-graduate	91	5,07	1,47	0,15	0,00
	Graduate	144	6,07	0,87	0,07	
Identified External Regulation	Non-graduate	91	4,40	1,73	0,18	0,00
	Graduate	144	5,27	1,36	0,11	

Injected External Regulation (Material)	Non-graduate	91	2,81	1,67	0,18	0,00
	Graduate	144	3,52	1,81	0,15	
External Regulation (Social)	Non-graduate	91	3,51	1,66	0,17	0,08
	Graduate	144	3,92	1,72	0,14	0,07
Demotivation	Non-graduate	91	1,35	0,50	0,05	0,00
	Graduate	144	1,13	0,33	0,03	
Psychological Capital Efficiency	Non-graduate	91	5,05	1,17	0,12	0,00
	Graduate	144	6,04	0,73	0,06	
Psychological Capital Hope	Non-graduate	91	5,02	1,18	0,12	0,00
	Graduate	144	5,75	0,76	0,06	
Psychological Capital Resilience	Non-graduate	91	4,89	1,35	0,14	0,00
	Graduate	144	5,53	0,88	0,07	
Psychological Capital Optimism	Non-graduate	91	5,04	1,30	0,14	0,00
	Graduate	144	5,60	0,83	0,07	

Looking at the analyzes segmented in their total context, the data suggest that the function, educational level, age and company time influence the Motivation for the work and the Psychological Capital of the employees. In particular, the data related to the educational level showed greater significant differences, provoking the need for future research with these variables.

Then the correlation analysis was carried out in which the results suggest a positive relationship between the four dimensions of Psychological Capital and Motivation for Work. Suggesting that the more the motivation results approach the classification of Intrinsic Motivation the greater the degree of Psychological Capital and the greater the scores obtained in its dimensions.

Table 5 – Correlations between Psychological Capital and Motivation

Factors	Intrinsic Motivation and Integrated External	Identified External Regulation	External Regulation (Social)	Injected External Regulation (Material)
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Psychological Capital Efficiency	<b>0,60</b>	0,42	0,25	0,16
Psychological Capital Hope	<b>0,63</b>	0,42	0,16	0,18
Psychological Capital Resilience	<b>0,49</b>	0,37	0,19	0,20
Psychological Capital Optimism	<b>0,62</b>	0,41	0,19	0,13

Observing Table 5 and considering motivation as a continuum process it is possible to conclude that the correlation values of the Psychological Capital' dimensions with the Motivation factors increase as they are directed towards more autonomous types of motivation.

In the conception of the Self-Determination Theory, Motivation is an internal psychological process that receives influences from personal needs and interactions with the environment. It is the relation between the satisfaction of the basic needs (autonomy, competence and bond) and the energy employed to reach them (Gagné & Deci, 2005).

Psychological Capital is considered as an 'internal psychological process', as a unique personal resource. The sharing of these four concepts of Psycap - Self-efficacy, Optimism, Hope and Resilience, endow individuals with cognitive ability that guides and develops people for a positive assessment of reality, giving the possibility to shape affective, cognitive and behavioral functioning of the subjects, through self-motivation, perseverance, and efficient effort that increase the probability of success in the tasks performed (Youssef & Luthans, 2007, Siqueira, Martins & Souza, 2014 and Avey, 2014).

In the words of Gagné et al. (2015) the SDT seeks to identify and understand the components of Intrinsic Motivation and Extrinsic Motivation and the factors that result in its promotion. Based on these theoretical conceptions and with the results found in this study it is indicated that there is a relationship between the degree of Motivation for work and Psychological Capital of individuals, and Psycap is a possible factor of this promotion.

## CONCLUSIONS AND LIMITATIONS

Through these two theoretical cuts, Psychological Capital and Motivation for work, it was possible to consider a new conception of science that seeks to understand the interconnected and interdependent reality, valuing the whole more than the sum of the parts. The studies deal with intrinsic values, hope, optimism, resilience and trust. Themes surround emotional health, work engagement, authentic leadership, the importance of ethical environments, and the appreciation of ecological awareness of respect for the planet we live in.

Although these studies find a scientific barrier: the difficulty of identifying, measuring and managing the subjective aspect in companies (Stewart, 2002) Self-determination Theory' authors when addressing the theme Motivation for work (Gagné & Deci, 2005) and Psychological Capital' authors (Luthans, 2002), dedicated themselves to developing instruments that filled this gap in organizational studies.

Considering the two theoretical currents: Psychological Capital and Motivation for work, the conclusions of this study can serve as guiding principles for works that wish to explore the relations of human behavior in companies. The data found and the use of the PCQ-24 and MWMS instruments can help further research with the intention of studying the subjectivity dimension of the individuals and their influence on the companies' results and the organizational context.

The results corroborate the claim that there is synergy between these two approaches. It is observed that the dimensions of Psycap are positively related to the more autonomous types of motivation for the work in the sample tested. These data can contribute to approximate the studies of these two theoretical fields of the human behavior in the organizations, being this another important contribution of this research.

Other results found in this study also include aspects that require further discussion and serve as a basis for further research and validation. For example, when relating the data 'Function' to the dimensions surveyed, the conclusions indicated that workers in the administrative area tended to have bigger job Demotivation and a bigger need for External Motivations to exercise their labor activities than those in the care area. Likewise, this administrative function presented a significant difference, for less, in the dimension Hope in relation to the workers of the other area surveyed.

Among other results of this research, which also deserve distinction, two issues marked more deeply. The first one was to identify in the sample studied that people with a college degree with a full course of study presented higher motivation for work and higher level of Psychological Capital. The relationship between this variable and the types of motivation for work resulted in the finding that schooling affects the levels of motivation. The data suggest that individuals with full graduation have higher motivation and lower demotivation at work than individuals without a full undergraduate course.

With regard to the Motivation for Work approach, Gagné et al. (2015) identifies that internal motivation is linked to the possibility of the subject integrating the activity of his work with personal values, endowing it with meaning. Individuals with full graduation may have the tendency to endow their work tasks with a greater personal sense than individuals without this schooling.

Regarding the dimensions of Psychological Capital, the higher the level of education, the higher the Psycap level. The dimensions Efficacy and Optimism appeared with the greatest differences between these two categories.

Recalling the definition of Psycap as a 'state' of positive psychological development, characterized by the individual having a set of attributes: self-efficacy: being confident and self-efficacious, in order to maintain the effort necessary to succeed in challenging tasks; optimism: make positive attributions about present and future events; hope: persevere in relation to the objectives and, if necessary, redirect the ways to reach the goals to be successful; resilience: overcome and return to normal emotional state in the face of problems and adversities (Luthans & Youssef, 2007), point to a possible interpretation that school education assists in the development of positive personality skills in the dimensions of Self-efficacy, Hope, Resilience and Optimism.

Speaking specifically of the Resilience and schooling dimension, people with incomplete graduation, high school and elementary school presented an average of 4.88 in this factor. This index, although close to 5, may suggest that the ability to recover from adverse situations at work, to adapt to changes, to have



flexibility and creativity is less developed than other positive psychological capacities (Luthans, 2002; Youssef & Luthans, 2007).

These data collected in the present study justify a new look to identify the relevance of these findings in the organizational context, presenting significant contributions of this research.

This research allowed to verify a lack of studies using the MWMS and PCQ-24 instruments in the Brazilian context, most of the research being applied in North American and Asian countries, which have as a reference a culture different from the Brazilian one and, the need to develop research involving a greater cultural diversity, from the collection of data in different countries, especially Brazil.

Another point concerns the sample used (health workers). The replication of the same with professionals from other sectors can make possible the generalization and expansion of results, as well as provide relevant information on the subject.

Another opportunity in the statistical exploration of these constructs is to test the interrelationships between the dimensions of Psychological Capital and Motivation for work within a theoretical model from the use of structural equation modeling.

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# **A propositive contribution to the mitigation of the credit problem on Brazilian solidarity economy enterprises**

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## **Abstract**

*The biggest impediment to the viability of Solidarity Economy Enterprises (SEE) is the credit issue, which due to lack of guarantees means that they cannot access credit through traditional banking channels and end up failing. In view of this unfavorable scenario, the objective of this work is to make a propositive contribution, evidencing elements that are useful to enterprises of solidarity economy in relation to obtaining credit. To do so, it relied on bibliographic research to link these factors, highlighting those that can be controlled by the SEE, as well as those external so that the credit assignment occurs, which resulted in the elaboration of a propositive instrument, with elements that facilitate the assignment of credits both in the user's view and in the institutional view. Its usefulness could be verified with a field research, conducted with 25 solidarity economy enterprises, which answered a questionnaire informing whether the existence of such an instrument would help in reducing the difficulties of obtaining credit, as well as being*

able to contribute with eventual adjustments.

**Keywords:** Solidary Economy; Entrepreneurship of Solidary Economy; Credit.

## 1. Introduction

In the modern competitive world, where the search for capital and its influence generates substantial increases in unemployment and social marginalization, a new organization, not only social, but also labor, has emerged and remains in vogue: the solidarity economy.

Gaiger and Laville (2009: 14), state that the term Solidarity Economy (SE) is used to conceptualize ideas that “revolve around the idea of solidarity, in opposition to the utilitarian individualism that characterizes the prevailing economic behavior in market societies”.

Singer (2001) explains that the solidarity economy involves various categories of companies, voluntary associations and workers' clubs that, guided by the solidarity premises, practice self-management, with democratic participation of all members, and they have the right to vote, division of the net revenue among cooperative members, in addition to promoting the possession of the means of production by those who use them to produce, which means, the extinction of the role of the manager / boss.

Lisboa (2005) mentions other examples of enterprises that apply solidarity economy, in addition to the traditional cooperatives:

Family farming, MST (Landless Workers' Movement) settlements, industrial or rural companies recovered by self-management, networks of collectors and recyclers, national and international fair-trade networks, business incubators, in addition to the 3, such as exchange clubs and indigenous and quilombos economies. (Lisboa, 2005, p.1)

Therefore, based on the exposed definitions, it is possible to state that SE is a counterpart to the capitalist form of production, which aims to promote solidarity, integration, and synergy among its participants, who are owners and workers at the same time, of these enterprises.

To understand the dimension of SE in Brazil, the Second National Mapping of the Solidarity Economy of Brazil (2013), carried out by the Ministry of Labor through the Solidarity Economy Information System (SENAES, 2013) shows that Brazil had, at that time, 19,708 Solidarity Economy Enterprises (SEE), in which 40.8% were in the northeast, 16.7% in the south, 16.4% in the southeast, 15.9% in the north and 10.3% in the Midwest.

However, even though the solidarity economy is a good alternative way to promote inclusion, a sense of belonging, and help in a local income-generating cycle, there are still severe difficulties faced by the SEE.

The National Mapping (2013) carried out by the National Secretariat for Solidarity Economy (SENAES), on the other hand, shows that the most recurrent problem and the one that most motivated bankruptcies was the difficulty of obtaining credit. According to França Filho, Silva Júnior and Rigo (2012), the solidarity economy suffers from commercial banks due to bureaucratic obstacles and the requirement of guarantees such as: bureaucracy of financial agents (27.5%); lack of support to develop a project (15.7%);

high interest rate (12%); lack of specific credit line (11.9%); and inadequate grace periods (6.9%).

According to the studies conducted by Kuyven and Kappes (2013) regarding the Second National Mapping, in the Brazilian south states, a region known for encouraging cooperative and associative movements, 55% of the SEE plea to have necessity for financing and obtaining credit, 7% of these claim that they do not even have money to pay the bills, which means, they are in deficit; 31% are in a neutral position, they are able to pay their bills, but there are almost no surpluses.

Valentin and Serra (2012) mentions, in another approach, still prior to the Second National Mapping (2013), not restricted only to the South Region, that 27.8% of the enterprises believed that the credit lines were very scarce, 22.9 % of enterprises did not access credit due to lack of documentation, 16.8% could not elaborate an adequate financing project, 15% considered interest rate as abusive, 13.5% did not have the necessary guarantees that commercial banks demanded and 4% they did not see the deadlines as adequate.

Valentin and Serra (2012) discuss the administrative discouragement that the lack of credit generates:

Without credit, associations, cooperatives, and informal self-employed workers in the sector are unable to make investments, have difficulties in acquiring raw materials and inputs, are unable to delivery production and, consequently, end up increasingly limiting their possibilities of generating employment and income, growth, and expansion of enterprises. (Valentin and Serra, 2012, p. 3).

Considering that the biggest problem shown by the references is credit the objective of this work is to make a purposeful contribution, highlighting elements that are guiding and useful to solidarity economy enterprises regarding credit obtainment.

The present work is developed from a bibliographic research, defined by periodicals and classic books of the themes, but mainly in official documents and references obtained in reliable and relevant collections such as Academic Google and Scielo, guided by keywords such as solidarity economy, enterprise, and credit.

For the analysis of the elements identified in the research, a categorization was established regarding the view of the actors involved: the institutional view, which means, external factors, that are not under the company' control, and therefore cannot be controlled, but must necessarily be observed; and the user's view, with elements that can be controlled and improved within the solidarity economy enterprises.

Having defined the categorization about the actors involved, the next step was to identify the elements that define their interest in the process of obtaining credit in the solidarity economy. This characterization allowed that a single theme - obtaining credit - could be analyzed from two different angles, but of equal importance for its realization.

Finally, a questionnaire with open and closed questions was applied, with the support of the Brazilian Association of Researchers in Solidarity Economics, to verify whether the propositional contribution, evidencing guiding and useful elements for solidary economy enterprises regarding obtaining credit proposed in this work are possible and if new important elements in this scenario arise from the questionnaires' answers.

Data collection was attended by 25 solidarity economy enterprises from different states and regions of Brazil and from the most varied purposes, such as production, consumption or collective use of goods, commercialization, provision of services, exchange of products or financial institutions solidarity, and others.

## 2. Brazil's Solidarity Economy Landscape

The landscape for the solidarity economy in Brazil, fourteen years after the creation of the National Secretariat for Solidarity Economy (SENAES), seems to be favorable. This argument is made in view of the perspective shown by Silva and Carneiro (2014) that out of the existing SEE, 65.1% were created from 2000, 27.3% in the 1990s, 5.9% in the 1980s, and less than 2% in previous decades.

The Rede Brasil Atual (2014) demonstrates that SE already represents an amount greater than 8% of all Brazilian GDP, which means, the sum of wealth produced in the national territory, this percentage being primarily formed by family farming associations, companies recovered and managed by workers, cooperatives for the collection of recyclable material and sewing, whose main goals are clean production, organic agriculture, and materials of excellent quality, preferably of cooperative origin.

In terms of structural matters, the Second Mapping, divided the SEEs regarding respect to their economic activities, focusing on six different classifications: a) exchange, b) production, c) commercialization, d) provision of services, e) credits or finances and f) collective consumption/use. The results are shown in table 1:

Table 1. Solidarity enterprises by main economic activity

Activities	Total	%
Production or production and marketing	11.081	56,2
Consumption, collective use of goods and services by partners	3.945	20,1
Marketing or marketing organization	2.628	13,3
Provision of service or work to third parties	1.296	6,6
Exchange of products or services	430	2,2
Savings, credit and/or solidarity finance	328	1,7
Total	19,708	100

Source: (SENAES, 2013).

It is interesting to notice that, although the theory initially preached a certain predilection for the exchange between services and goods, today there are few solidarity initiatives that effectively subsist in an exchange system. The solidary principle of economic efficiency, which is, the prerogative of having an administration and management capable of generating surpluses to share among the associates is much stronger in this sense.

The predominance of these SEEs is also more common in rural areas. According to SENAES (2013), 54.8% of the enterprises are in rural areas, 34.8% in urban areas and 10.4% in both. From the ones located



in rural areas there is a greater predominance of responses saying that their economic activities are linked to exchanges (65% of the total) and 85% of the total responses to consumption.

SEE, in addition to providing a high sense of sociability and including - naturally - people who would often be marginalized, also demonstrates that it can be an excellent form of inclusion for women in leadership positions. SENAES (2013) reports that there were 86,040 women who occupied coordination/leadership roles at the time, against 66,696 men. The most notable thing is that women are still a (substantial) minority in absolute numbers in these enterprises (803,373 men, 620,258 women).

When addressing the issue of employability, since a severe economic crisis hit Brazil (in 2015), the solidarity economy has been debated as a viable possibility for unemployment. Aquino (2017) even shows that this theme has been taken up by state governments (the report specifically is about the Bahia State) and that the benefits would be several: removal of people from economic inactivity; increased sense of belonging; generation of community and local income, which would ensure improvements in conditions in specific places and with immediate return to people.

An important study by Kuyven and Kappes (2013), conducted by the methodology proposed by Gaiger (2007) revealed that from the first, carried out in 2007, to the second mapping of solidarity economy, the one that survived in the following six years, were primarily those that had a better solidarity index, instead of greater entrepreneurship, as this motivated better job stability for members.

The authors also show that some factors that helped the survival of these enterprises were: transparent management, higher quality, ability to obtain credit and investment, remuneration and regular association with workers, investment in human resources training, broad market penetration, and vacation and/or weekly rest for members working at the SEE.

Silva and Carneiro (2014) demonstrate that the main motivations for the composition of some SEE are financial. Based on SENAES (2013), in its tabulation it is possible to notice that 48.8% of the total sought to be a complementary source of income; 46.2% for being an alternative to unemployment; 43.1% higher gains in associative enterprises.

Also, the returns seem to exist, since, according to the authors, 43.2% of the SEE had surpluses after the payment of their expenses, showing that the economic side in solidarity economy is where its most creative and interesting aspect is presented. It is in the restrictions they suffer from the conventional banking system for obtaining credit that solidarity economy enterprises create methods, also solidary, of financing. The next topic will address what was created.

### **3. Solidary finance and economic sustainability in the solidary economy**

The distortion that represents the greatest impediment to the survival of Solidarity Economy Enterprises (SEE) lies in the difficulty of obtaining and maintaining credit. Because they are mostly small and often unable to offer the guarantees that the conventional financial system requires, many of these enterprises are marginalized and doomed to bankruptcy, with no resources to invest and - often - with cash difficulties.

To mitigate these problems, the solidarity system decided to find its own financing methods that encompassed the same logic of solidarity, cooperation and collective participation, thus giving rise to the

so-called solidarity finance.

The National Secretariat for Solidarity Economy (2013, n/p) describes that:

Solidary finance is distinguished from the conventional financial system by the rules of access and qualitatively differentiated operation that are defined jointly by communities or group of associates. (...) the purposes of solidarity finance initiatives are related to achieving common goals, promoting local development by stimulating consumption and production of goods and services from the community itself. Distinguishing itself, therefore, from the financial system that aims to accumulate or increase financial resources based on speculation.

According to Singer (2003), the main way of promoting solidarity finance occurs through credit granting, most commonly through microcredit. In the definition of the Central Bank (2002), microcredit represents small amounts lent to small informal entrepreneurs and microenterprises without access to the traditional financial system.

To put all these operations into practice, Singer (2003) clarifies that three pillars support this initiative: credit unions, community banks and solidarity funds. All these forms will be arranged in the subsequent subtopics.

### **3.1 Credit unions**

The definition of the Central Bank (2018, n/p) for this cooperative modality is:

Credit cooperative is a financial institution formed by the association of people to provide financial services exclusively to its members. The cooperative members are both owners and users of the cooperative, participating in its management and enjoying its products and services. In credit unions, members have the main services offered by banks, such as checking accounts, financial investments, credit cards, loans, and financing. Members have equal voting power regardless their share in the cooperative's share capital. Cooperatives are not aimed at profits, everyone's rights and duties are equal, and membership is free and voluntary" (Central Bank, 2018, n/p).

To understand what motivated its creation, it is worth remembering the conditions that were imposed on workers in the second half of the 19th century. Workers lived a vicious cycle in relation to capital, which is, they did not have enough to meet the basic needs of their families, men and children worked extremely exhausting days in production without rest and always ended up resorting to loan sharks to solve their food demands or in search of better conditions. If this high level of indebtedness were not enough, they were still often forced to buy from their own bosses, as they also owned the businesses. Thus, the cycles of indebtedness and nonpayment were enormous.

In Brazil, it took some time for credit cooperatives to emerge. In fact, it was a Swiss priest, named Theodor Amstad, who brought this culture to Brazil, in the late 19th century.

It is stated in the Organization of Brazilian Cooperatives (OCB) (2017) that Amstad's ideas and willpower were the driving forces for cooperatives to expand in other Brazilian states. Currently, the oldest in Brazil and still in operation is Sicredi Pioneira, in Nova Petrópolis, from 1902.

The strength that Brazilian cooperatives have taken on is significant, being the sixth largest financial

entity in the country. The Cooperativismo de Crédito Group (2016) shows that they hold 3.57% of all Brazilian banking assets, 6.84% of deposits, 3.42% of credit operations, being ahead of large banks, such as Safra, Citibank and Banrisul.

According to the 2016 report by the World Council of Credit Unions (WCCU), the world has 68,882 credit unions that serve more than 235 million people, with 170 billion dollars in reserves, 1.7 trillion dollars in assets, 1.2 trillion in loans, and 1.4 trillion in savings.

It is possible to verify that credit cooperatives have ample conditions to show a path with greater participation in the Brazilian scenario. Its contribution is immense: in addition to promoting inclusion and more humane conditions to the financial circuit, it also provides returns to its members.

### **3.2 Community Development Banks**

The second form of solidarity finance to be presented is the Community Development Banks (CDB).

According to Silva Júnior, Gonçalves and Calou (2007), CDBs are experiences of solidarity economy that aim to support the development of popular economies in places where there is high social vulnerability. Its main features are:

- a) Management by the community itself, regarding to service administration;
- b) Integrated system for credit, production, marketing and training;
- c) Circulation of social money currency, in parallel to the country's currency.

The relevance to the social issue of this type of solidarity financing method is mainly the social and financial inclusion provided. According to França Filho (2004), this social utility of financial investment implies the ethical application of money, through the promotion of actions that go beyond the economic purpose, but that also incorporate other values such as the fight against exclusion, the issue of environmental preservation, the appreciation of culture, aiming the local development itself. Thus, it is proposed that the initiative comes naturally from society, and not be imposed.

Banco Palmas, the most relevant case of CDB in Brazil, had a similar beginning. França Filho, Silva Júnior and Rigo (2012) report that the creation of Banco Palmas took place in Conjunto Palmeiras, a district away from Fortaleza State, in 1981, when the Conjunto Palmeiras Residents Association decided to fight against public authorities for basic conditions of existence, such as access to clean water, education and health. Once these basic infrastructure rights were achieved, the second major struggle was to reduce the economic marginalization that existed there. The Bank itself appears with the perspective that there was an enormous capital potential in that group, which, if channeled, could be turned into benefits in the community itself.

Today, Banco Palmas, which has become a correspondent for Banco do Brasil in areas without a bank, has proved to be a great success, with more than 103 branches spread across 19 states. With millions lend every year, both in Brazilian reais and in social currency (MORAES, NOGUEIRA and VIEIRA, 2015).

According to Singer (2009), the social currency started in Brazil at Banco Palmas in 2000 and was used exclusively by exchange clubs that occurred twice a month. It was a way of quantifying the exchanges that occurred, giving a symbolic value to the goods. Since the main bases of exchange were food, handicrafts, and clothes, it was easy to promote this exchange.

Its regulation is all made by the Central Bank according to the Law 12.865/13 and has been shown

to be a great success, since: a) it promotes the financial inclusion of marginalized agents; b) it has a low maintenance cost as it is a web platform; c) it has a greater level of security and transparency, in addition to adding new forms of exchange that do not exist for physical currency. Mostagi et al (2019), corroborate the idea that Banco Palmas serves to guarantee the circulation of capital in the localities of its scope.

As well as the credit cooperative apparatus, community banks have a sophisticated operating system. It is also backed by the Central Bank and is certainly the one that presents the most creative and safest ways of local development. Its social currencies create a virtuous cycle of income flow. And there seems to be enormous social support for them, given the sense of belonging and the low default rates.

The last of the constituent methods of the solidarity economy is the revolving funds.

### **3.3 Revolving funds**

The last form of solidarity finance to be presented is the revolving funds.

According to Santos Filho et al (2013), solidarity revolving funds consist of financial support, flexible payments, intended for associative productive activities, which use basic principles of solidarity economy, such as shared management and solidarity.

Gonçalves (2010) explains that, these funds are actually a community savings and that part will be reinvested in the community itself, for collective benefit. The main idea behind the initiative is, according to the author, in addition to the extensive fight against hunger, the availability of resources, with reduced bureaucracy, to produce goods and services.

Singer (2009) reports that revolving funds tend to be used more in rural than urban areas and are shown to be of great importance for the acquisition of small machines, fences, cisterns for better rainwater collection and storage.

A similarity that exists between revolving funds and community development banks is that both are used as government arms to promote public credit policy and to combat poverty. Singer (2009) reports that, through Banco do Nordeste (BNB), the government supports micro-entrepreneurs in the semiarid region.

Essentially, all three proposals for solidarity finance do an enormous job of fighting marginality, social promotion, financial inclusion and breaking the cycle of poverty.

## **4. Elaboration of a propositional contribution to mitigate credit problems**

Considering what was exposed above, so far in the context of the solidarity economy, some facts and characteristics are interesting to be observed to contribute to the achievement of this work's goal.

A first point to be considered when listing these elements, which the analysis will focus on, must necessarily be the classification of the economic activity performed by each of these enterprises. It is considered that there is a better adaptation to the proposed model, as close as the activities performed by the SEE. Throughout this work it was explored that there are six distinct categories, ranging from solidarity economy to commercialization.

Not only does the classification of the economic activity of these enterprises appear to be striking, but also the structure in which these companies are organized. In the introduction, it was exposed that family businesses tend to have problems of disassociating the equity of the partners and the company. The

risks embedded in these operations tend to be too high with this configuration.

Also indispensable for analysis, to mitigate credit problems, it appears to be the size that these enterprises have acquired and whether there are solidary supply chain networks. This has been pointed out as a very relevant factor for the survival of the components of the solidarity economy, since it makes it possible to create synergy, gain strength and plurilateral development, which means, all those involved in the association process end up winning, either in cost reduction or efficiency gains. The creation or not of value chains may prove necessary to understand the credit difficulties faced.

The financing methods used by the cooperatives should also not be neglected and the perception of each of them are an important element. A reasonably common movement among larger cooperatives and greater availability of resources is the creation of large funds or banks for their own contribution and use.

Additionally, knowing if there are solidarity finance institutions in the locality in question can also be a major factor in future decisions for those who suffer from all the restrictions already discussed throughout the introduction, the second chapter and so strongly presented by the Second National Mapping of Solidarity Economy.

Considering the main point of this research and having previously pointed out that one of the biggest problems listed in the Second National Mapping of Solidarity Economy (2013), refers to obtaining credit, it is also important to analyze whether interest rates for projects would make it possible to take or if there are specific lines of credit for such investments, if there is support for the elaboration of this type of projects and, finally, if the terms negotiated would be achievable.

State presence must also be analyzed as a driving force for the local development of enterprises. Because it is the greatest guiding force, regardless of which instance is treated, the State is the only agent capable of formulating public policies to achieve its objectives. The existence of these targeted policies can be a promoter and a facilitator in obtaining credit.

Another consideration to be made about the enterprises to be studied, is the corroboration or refutation of the information exposed during the theoretical construction, which says when comparing the first and the second national mappings, it was realized that those enterprises that presented greater levels of solidarity, considering the aspects of self-management, cooperation, economic management, and solidarity.

Finally, the last consideration to be made on the aspects of the enterprises studied refers to the problems experienced by them. It is not possible to propose any way of mitigating problems without understanding what they are.

Tables 2 and 3 show the synthesis of these concepts just demonstrated, highlighting the elements that facilitate obtaining credit and the reasons why they are important, divided into two categories: user and institutional.

The elements for the users are those that can be controlled and improved within the solidarity economy enterprises themselves, while in the institutional category are external factors, which are outside the company's control, and therefore cannot be controlled, but must necessarily be observed.

Table 2. Elements that facilitate credit obtaining - user view

Element	Reason for being important in obtaining credit
Economic activity classification	It is clear throughout the conceptual exposition that those projects closer to productive activities are easier to obtain credit. Analyzing the classification of economic activity may help to substantiate the applicant's situation with bank agents.
Enterprise structure	Throughout the theoretical constructions, it was noticed that overly familiarized, unprofessional enterprises tend to have more difficulty obtaining credit, where the partners' assets are confused with those of the company; thus, a critical element to the risk factors and consequent increase in credit.
Presence of solidarity supply chain	The presence of a supportive supply chain creates a virtuous cycle between enterprises. This income stream, besides being able to leverage business, can also result in collective financing, if it favors the chain as a whole.
Presence of solidarity finance institutions	Solidary finance institutions are not conditioned by conventional market logic and are not driven by assets. That is why they present less bureaucratic requirements, more humane treatment, and greater capillarity to micro enterprises.
Support in project development	15.7% of the enterprises listed in the Second National Mapping indicated that a severe impediment to obtaining credit is the difficulty and/or lack of support in the elaboration of their projects. Because they are small and often unprofessional, the difficulty of presenting a coherent project ends up becoming an impossibility before financial institutions.
Scale of solidarity	In carrying out the two National Mappings of the Solidarity Economy, it was noted that primarily those with a greater level of solidarity survived and showed better robustness. The level of solidarity seems to be a good indication of the viability conditions of undertakings of this nature. Furthermore, the link between solidarity and the longevity of the enterprise is a special symbol of the issue of social and financial sustainability.

Source: Elaborated by the authors.



Table 3. Elements that facilitate the credit grant - institutional view

Element	Reason for being important in obtaining credit
Financing methods used	The financing methods used by the success cases studied here are relevant to the understanding of credit viability, since it allows plans to be drawn up for projects that come to be situated on what possibilities they can claim so that they can provide access to capital.
Interest rate applied to projects	Interest rates were also pointed out in the latest National Mapping of Solidarity Economy as being a big problem. Because of the need for guarantees that these enterprises often cannot offer, banks tend to embed these risks in interest rates.
Existence of local Public Policies	As can be seen when analyzing community development bank initiatives, the government has a significant role in encouraging the reduction of poverty and disparities. There are very virtuous local examples, such as the city of Maricá (Rio de Janeiro), in which the government led a series of public policies to strengthen the local solidarity economy.
Specific line of credit	Not only in solidarity finance institutions, but also in government banks, there are specific lines of credit for some types of acquisitions, such as machinery. In 2012, 11.9% of these institutions pointed out that the lack of a specific line was one of the reasons that impeded their financial viability.
Grace periods	7% pointed out that the terms stipulated by the financial agents were of little interest to the viability of their financing. So, it seems clear that such enterprises, in order to be able to honor these investments, need adequate terms so that there is no disruption of their working capital and cash.

Source: Elaborated by the authors.

The tables created contemplate the objectives outlined for this work in full, which means, they are two propositional contributions that help solidarity economy enterprises to reduce the difficulties of obtaining credit through relevant elements from the user and institutional point of view.

The use of this instrument also serves as a decision support tool for companies that may use it. Assuming, for example, that there is a cooperative with plans to obtain credit for an expansion of the production, knowing that the bank guarantees are serious, surely this company will pay attention to the

highlighted institutional and user elements.

It will check, for example, if the business has a full distinction between the capital of the members and the cooperative, if it has the capacity to develop a project acceptable to banking institutions, if there are solidarity banking institutions (community development banks or credit unions) because they tend to have more accessible financing conditions and whether it would be possible to create synergy with other cooperatives for mutual benefit.

Having all these factors aligned and well defined, it is a good time to verify the conditions related to the credit claim. In the past, which institutions apply for this credit? What interest rates are applied by banks? Is any improvement possible, either through public policy or via a specific credit line? What is the deadline for payment?

The compilation of these data will serve as a guiding point for the company's decision making and internal rearrangement of any weaknesses that hinder credit grant to the solidarity economy enterprise that uses it.

## **5. Evaluation of the elements suggested in the propositional contribution**

The present work would be sufficient in its contribution, if, through its elements, could serve as an aid to resolve the difficulties of obtaining credit. However, it is important to consult solidarity economy enterprises to find out if the elements proposed in this work are significant for obtaining credit and if other elements not highlighted, could complement the proposal. Thus, 25 solidarity economy enterprises were consulted.

The answers were obtained through a field survey, a questionnaire with 15 questions, part of which were open, partly closed and had the help of the Brazilian Association of Researchers in Solidarity Economics so the sample was heterogeneous and had a capillarity in different areas of the country.

Out of the 25 enterprises that responded to the form, there was representation from all regions of the country and, as in the Second National Mapping (SENAES, 2013), the production or commercial institutions were the majority 72%, savings, credit and solidary finances, consumption, and provision of services represented 8% each, and marketing organization 4%.

However, not only cooperatives responded, in fact, informal groups were the most representative category, with 40%, followed by associations and cooperatives, with 28% each, and commercial society with 4%. Such enterprises had the mostly mixed structure, which is familiar with some professional activities, representing 60%. The totally familiar ones represented 28% of the interviewees, and the totally professional ones 12%.

This point was considered relevant in the conception of the proposal, as it was found that those enterprises with less professionalized structures, had more difficulties in accessing credit. In the field application, it is noted that the majority of enterprises have familiar structures. It is not possible to know in detail whether there is a distinction between the assets of the partners and the enterprise, but this is understood to be one of the most difficult points of obtaining credit.

When asked about the reasons that make them participate in these enterprises, the answers were: alternative to unemployment, 28%, development of activity in which everyone owns, 20%, complementary

source of income, 16%, social, philanthropic, or religious motivation, 12%, condition required to access financing, 8%, obtaining greater gains, 4%, and others, 12%. In this categorization of "others", the answers were open and surprising: one person replied that the solidarity economy was a way out of domestic violence, another said that it was identification with the community cause, another to obtain technical advice and other wanted to reach a minimum wage.

In this question, two extremely relevant points of the solidarity economy are highlighted, which is the possibility of creating bonds, the sense of belonging and human emancipation, as it can be seen in the open answers. Also, that the financial theme, which is, earning income is the main motivator for people's participation.

However, there is a curious fact: despite this being the main reason, there were few projects that registered residuals in 2019. Around 64% of the projects claimed that there was no surplus in the last year and those that were able to obtain, the applications were the following: reserve fund for contingencies, 16%, distribution among partners to pay up capital, 8%, investment reserve fund, 4%, reserve fund to support other projects, 4%, and other types of allocation, 4%, with no register of what this other destination would be.

The absence of surplus or the application in reserve funds may help to understand the reason why, in 2019, 52% of the enterprises had not sought financing, 40% had tried but with no success and only 8% had tried and obtained.

In this sense, the situation of the enterprises seems to be alarming, there is a majority of these that cannot obtain surpluses and another significant portion trying to protect themselves from the worst, by making reserve funds. Only a minority using shareholder capital

To those who had their requests for credit denied (this question was timeless), 44.4% of the answers pointed out that it had been due to the lack of a specific credit line, 33.3% due to the lack of support in the project elaboration and 22.2% highlighted high interest rates.

However, the answers presented other features when asked which of these elements they considered important for obtaining credit which would make it more difficult (this question accepted more than one answer). In the interviewees' view, the biggest obstacle was the lack of support for project development, 52%, followed by bureaucracy from financial agents, 40%, lack of specific credit line, 32%, high interest rate, 24%, and inadequate grace periods, 12%.

These points are consonant with the theoretical construction, in the sense that everyone is seen as relevant and, in a way, directly impacting credit obtaining. It is curious to notice that the ranking of these variables has changed since the Second National Mapping (2013), at that time, the agents' bureaucracy was considered the biggest obstacle, followed by a lack of support for project design, adequate interest rates, lack of specific credit line and, finally, inadequate deadlines. In the interviews conducted by the present study, it is noted that the lack of support for project development gains greater notoriety. The lack of a specific credit line also seems to have been more highlighted in the reality of the projects.

From the presence of solidary finances, 52% of the interviewees claimed that in their localities there were no such institutions, however, in the event of existence, there was no unanimity on whether these were the ones they preferred to obtain credit. Also, 88% of respondents would prefer solidarity finance institutions, while 12% would choose public or private banks.

It is known that the institutions participating in solidarity finance have a tendency to apply lower interest rates and greater support for microcredit, the inexistence of these institutions in more than half of the locations surveyed is a good indication for the previous answers (excessive bureaucracy, high interest rate etc.).

There is also a great lack of knowledge regarding public policies that could benefit them, 56% of the enterprises were unaware of whether there were specific lines of credit or local public policies, coincidentally, this is the same percentage of those who say they do not need financing at the moment.

Being the state as one of the major credit inducers and even with large resources directed towards family farming, just to mention one of the branches in which it is most present, the lack of knowledge regarding public policies is extremely harmful to the enterprises that seek financial or credit obtaining.

When looking at the tabulated data of the answers, it is clear that the propositional contribution of this work is relevant, and is even the only unanimity throughout the research, which is, that everyone believed in the usefulness of a support instrument that listed relevant information obtaining credit.

However, despite the efforts of this field research to raise other elements that might have gone unnoticed in the theoretical construction, no other element came from the answers from enterprises, on the contrary, it served to reaffirm that the propositional contribution goes in the right direction.

## **6. Conclusion**

The present work aimed to make a propositional contribution to the mitigation of problems in the granting of credit to solidary economy enterprises, and it did so through the elaboration of two analysis instruments, one from the user's perspective and the other from the institutional perspective, and a field research that had a wide representation of solidarity economy enterprises that were able to validate the pertinence and adequacy of the proposed elements.

The division into the two categories that constituted the propositional contribution was made so that there was a clearer measurement between what can be controlled by the cooperative, as an internal foundation, subject to corrections, and what is beyond its control, but impacts severely their activities and more, the possibility of obtaining credit.

With the conceptual theoretical basis survey, it was possible to notice that the solidarity economy plays a significant role in the lives of millions of people directly and indirectly, considering that, as highlighted throughout the research, not every solidarity economy enterprise has automatic alignment with the solidary premises, in fact, there are many of these institutions that only appear for some kind of self-improvement, such as the Coopergatos<sup>1</sup>, for example, that end up promoting greater spoliation of workers and impoverishment of rights. These kinds of institutions must be rejected.

However, this article demonstrates that the obstacles to financial sustainability and longevity are undeniable.

A small part of this conclusion at this point should be referred to the condition of solidarity finance institutions, as their social and local relevance is greater than the simple relationship between community and bank. Especially in Community Development Banks, as the community is a constituent part and the

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<sup>1</sup> Coopergato is a term used in Brazil to define cooperatives used to bypass worker's rights, operating with no registration.

driving force behind its creation, its relationship with the institution transcends. It is this relationship that even allows social currencies to become viable and even when they fall into disuse, the consumption of that location does not reduce. And it is exactly this relationship that prevents non-organic replicability of these institutions, not being pre-made products, but the result of a social clamor.

Regarding credit unions, they are relevant instruments for the insertion of people in the so-called “financial market”, providing, through a more humanized treatment, the possibility for people to identify themselves as citizens. Their links are even closer due to the fact that, as cooperative members, they are called to express their opinions in decisions, through assemblies and do not necessarily need this organic movement for their creation, being capable to be replicated in other locations.

The field research served to raise questions about the conditions of solidarity economy enterprises, which can be worked on in future works such as: what kind of subsistence people are managing to get from the institutions they belong? How can the familiar structures of the enterprises be a factor that prevents the adequate elaboration of a project? Are there any public initiatives to make these enterprises aware of public policies and specific lines of credit?

And yet, even with all the efforts of the so-called solidarity finance to promote a more influential access to the financial system, with lower interest rates, lower guarantees requested and longer terms, the financial difficulties are still too serious for the SEE, which still end up having their lives shortened by the lack of capital investment.

The relevance of this work and its contribution is precisely in wanting to mitigate this type of obstacles, to make sure that the enterprises have minimum conditions to react to this situation, to become more professional and with better conditions for structuring and basis for decision making.

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# **CVRRICULUM Program: Benefits and Challenges of Embedding Virtual Reality as an Educational Medium in Undergraduate Curricula.**

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## **Abstract**

*Since the release of more affordable, portable, and easy-to-use virtual reality (VR) systems in 2014, there has been renewed interest in using this technology in education, as an alternative to traditional learning, because it creates more opportunities for experiential education. Despite the many benefits and affordances of VR, widespread adoption in post-secondary education has been limited, and gaps remain in the provisioning of detailed guidelines for implementing this technology in curricula. Our team developed the CVRRICULUM (CVR) initiative: a pilot program that recruited instructors to adapt a traditional written assignment into a VR format. A mixed-methods approach was used to collect data from five instructor and 18 student participants. In this manuscript we describe the implementation process, report the identified challenges, and provide suggestions that should improve subsequent offerings. Our team addressed raised challenges by creating a set of resources available on the CVR website.*

**Keywords:** Virtual Reality; Experiential Education; Nursing

## **1. Introduction**

### **1.1. Background**

Virtual reality (VR) has been used in aviation training for over half a century (Page, 2000), but for many years VR technology required costly resources, highly skilled technicians, and a large infrastructure footprint to function, limiting its wide adoption in education (Kavanagh et al., 2017). After a series of failed attempts by multiple tech companies to introduce VR into the commercial market, the field began to make

headlines again in 2012 with the enormous success of the Oculus VR Kickstarter campaign, which led to the development of a wearable headset with stereoscopic displays providing the ultra-wide field of view (100-degree) needed to create the immersion promised by VR pundits decades earlier (Hussein & Nätterdal, 2015). Finally, in 2014 “Google Cardboard” was released, serving as a catalyst in the development and adoption of mobile VR (Boyles, 2017), with a number of other companies, such as HTC, Samsung, and Oculus, following suit and creating VR devices that are much smaller, more affordable, and easier to use, making them excellent tools for education more broadly.

### **1.2. Types of VR**

To frame conversations around VR and its implementation in education, we must first provide a high-level understanding of the field and the various modalities, hardware, and software used, and acknowledge the differences between them. Although exact definitions of what constitutes VR differ in the literature, most describe a system of technologies that provide the user sensory information through, for example, visual, auditory, and tactile displays, and that offer varying degrees of immersiveness, but at minimum they provide a digital representation of a three-dimensional (3D) object and/or environment (Author et al., 2020). Two common distinctions across VR systems that have a critical impact on immersiveness are (1) how the virtual environments are created, and (2) whether devices are stand-alone or connected to multiple devices. Virtual environments can be created through either rendered graphics or live 360-degree video footage. While graphics allow for greater customization and ability for the user to interact and affect change in the virtual environment, these environments are more costly and complex to create, and depending on the skill level of the programming, may lack realism compared with 360-degree footage (which is regular live-action video captured in 360 degrees field of view). If we were to limit our discussion to wearable VR and exclude CAVE systems (immersive VR environments where images are projected onto three to six walls in a room-sized cube; Cruz-Neira et al., 1992), which are frequently used for clinical and research purposes, we could categorize hardware into two main kinds of systems: head-mounted displays (HMDs) that are tethered to an external computer (e.g., HTC Vive), and standalone HMDs (Oculus Go). Further, the sensors that track a user’s motion and replicate their movement in the virtual environment can be either external to the HMD or built into the headset itself. Similarly, headphones built into headsets or external loudspeakers can generate spatialized binaural sound. Each of these modalities and respective devices has its benefits and costs, and selection should be based on the desired learning objectives and the resources available to support the implementation in education contexts.

### **1.3. VR in Education**

Most educational applications of VR are found in post-secondary and graduate settings (Kavanagh et al., 2017). Hussein and Nätterdal (2015) report on students enrolled in a science course that used VR to visualize chemical reactions and systems in the human body, and to explore the solar system. Engineering students have used VR to watch animations of electrical machines to help them interpret electrical diagrams (Boyles, 2017). VR is perhaps most commonly used in medicine: for interpersonal training and learning to take medical histories from virtual patients instead of standardized patients, for visualizing internal organs from real-patient scans built into 3D simulations rather than cadavers (increasing the number of students

who can learn from one patient), for using tactile and haptic affordances of VR technologies to improve the fine-motor skills needed for laparoscopies (Huber et al., 2015) and orthopaedic surgeries (Fang et al., 2014), and for getting used to high-stress environments like the operating room through 360-degree films complete with sound. Zackoff et al. (2019) studied the perspective of medical students on immersive VR in clinical training and found that the majority of participants reported a sense of presence and perceived VR as an effective alternative to traditional clinical training. This finding was consistent with those of Real et al. (2017), where learners perceived VR usage as equally effective as the use of standardized patients for clinical training. Moreover, due to the presence afforded by the devices, the system has been considered an effective tool for empathy training and building through exposure to multiple persons' perspectives (Ventura et al., 2020).

Another way VR technology has been used in pedagogy is through its application to distance learning. While remote and online course offerings have been steadily growing in popularity across post-secondary institutions, the global COVID-19 pandemic catapulted university investment in virtual learning (Allen & Barker, 2020). As just one recent example, in the wake of the pandemic, the Faculty of Science at Ryerson University in Toronto created an augmented reality (AR) remote education platform called RALE that includes real-time collaborative Zoom sessions with lab technicians and fellow student lab partners complemented by AR lab exercises that allow students to project into their home the lab materials required for each experiment (Grady, 2020).

#### **1.4. VR Affordances**

VR is considered a unique tool for teaching because it can replicate difficult-to-reach or otherwise impossible environments with high fidelity, for example, going into the past (Perez-Valle, Aguirrezabal, & Sagasti, 2012), going into the human body and understanding things on a biological level (Hayden, 2015), going into space (Hu-Au & Lee, 2017), and disaster preparedness. Learners are also able to practice their skills in a safe environment, as is the case with surgical skills training (Pulijala, et al., 2018), and in many cases VR creates opportunities for experiential education when excursions or in-situ placements are hard to come by, as has been the case for nursing students needing to find hospital placements in order to complete their training (Smith, 2010; Jacobs, A. C. (2020). VR technology allows for control over exposure variables, thus providing the ability to adapt and customize a learning experience for an individual's skills and abilities (Abichandani et al., 2014). In this way, students can repeatedly try a task, and have factors increasing in complexity and difficulty as they master each phase, and educators can build in gamification applications in order to further motivate students to improve their abilities. For example, Smith et al. (2018) created a simulation of an emergency department room and featured a patient on a stretcher, where "players" (i.e., students) selected relevant tools (e.g., available personal protective equipment) and actions (e.g., remove patient's tainted clothing). Adding complexity to this scenario could include introducing competing interests (e.g., more than one patient) or disruptive environments (e.g., additional sounds). Perhaps most importantly, VR was found to be a means of enhanced engagement and immersion for students compared with traditional learning environments (Hu-Au & Lee, 2018).

### 1.5. VR Challenges

Despite these advantages, a recent systematic literature review on the topic of VR in pedagogy found substantial issues and limitations in implementing VR in education, many highlighting (1) the continued complexity of the programming required, and (2) the lack of “usefulness” or fit between the use of VR as a medium and the ability to reach learning objectives (Kavanagh et al., 2017). Nguyen et al. (2018) found that although VR is a good learning tool, when students lacked programming skills, they found projects challenging and reported having spent more time learning how to use VR than actually using it. From a teaching perspective, the lack of instruction for implementing VR in courses is a major limitation. Dunleavy, Dede, and Mitchell (2009) concluded that it is critical to understand existing effective instructional designs and to develop customized and outcome-specific assignments for better integration of VR/AR into education.

Based on these identified gaps and potential, our team developed and proposed to pilot the CVRRICULUM (CVR) initiative: a program that attempts to incorporate mobile VR technology into existing curricula and to evaluate its ability to create opportunities for experiential education and empathy building.

## 2. Research Questions

Primary RQ:

1. Is it possible to adapt an existing undergraduate curriculum assignment into one that employs VR?
  - What are the challenges?
  - What are the benefits?

Secondary RQ:

2. Is the VR medium an effective means of experiential education?
3. Is the VR medium suited for teaching empathy?

## 3. Methods

The CVR initiative was an attempt both to *implement a program* in existing curricula (applied project) and to *evaluate the program* and its pedagogical merit (theoretical contribution). In this manuscript we describe the protocol and results of implementation (related to RQ1). The secondary research questions are associated with the evaluation of the program and are described in a separate paper.

### 3.1. Equipment

The following VR equipment was used throughout this project: an Oculus Go VR Headset, a Yi 360° VR Camera, and a Bushman Panoramic Tripod. These devices were selected for their simplicity and their fidelity of experience. The Oculus Go was chosen for its relative affordability, its portability (mobile and wearable) and ease-of-use (stand-alone requiring no external hardware), and its built-in head tracking module, which greatly improves motion latency, reducing the chance that the user will experience simulator sickness caused by motion lag, often experienced with other, lower-end headsets like the Google

Cardboard. The Yi 360° is a small, lightweight VR camera equipped with two 180° lenses, capturing 4K 360° film; most importantly, it can automatically stitch internally without user input. Finally, the Bushman Panoramic Tripod is ideal for 360-degree film capture: it minimizes the footprint captured by the 360-degree cameras because the legs of the tripod extend only from the base of the stand, very low to the ground, allowing 360-degree panoramic photography and 360-degree VR videography. It was our goal to minimize the technical barriers identified as a main challenge by Kavanagh et al. (2017) and to focus on evaluating and providing suggestions for improved program implementation.

### ***3.2. Program Implementation***

Five course instructors were selected using purposive sampling based on one of the principal investigator's deep understanding of the course material. All five agreed to participate in the program, which involved (1) attending a faculty workshop, conducted in November 2019; and (2) recruiting from their third-/fourth-year courses in the upcoming semester. The faculty workshop was run by the two principal investigators and held on campus at a convenient time for all participants. The workshop taught faculty about VR and provided some basic instructions for using the equipment. As part of the resources for this workshop, the team created easy-to-use manuals for both the VR camera and the HDM. Time was also spent describing how the researchers envisioned the CVR program being implemented (discussing some course assignment examples), with the understanding that it was a pilot initiative and that elements would remain unknown until implementation. Finally, time was set aside to guide instructors through adapting a current assignment from their syllabus to a VR-based one that would maintain the expected course outcomes.

To support the faculty members in implementing the program, two research assistants (RAs; undergraduate students in digital media at the same institution) were hired and assigned as “navigators” for each course. The RAs were responsible for managing the lending of the equipment and for providing as little or as much hands-on help the student teams required. This flexibility was critical, as the assignments differed greatly, as did the skill levels of each student group.

### ***3.3 Data Collection***

A mixed-methods approach was initially approved (ethics approval was received from York University #: e2019-368) for evaluating the effectiveness of the program through pre/post questionnaires (administered in-class), anonymous student reflections (submitted online), structured observations from the RAs assigned to each student group (conducted when student groups interacted), and, at the conclusion of the program, focus groups with participating faculty and students (held virtually).

For details regarding the questions and instruments included in the survey, question prompts provided to students for completing the online reflection, the structured observation guide used by RAs, or the interview and focus group script, as well as access to the complete transcribed data, contact the corresponding author.

### ***3.4. Changes to Protocol due to COVID-19***



The pandemic reached its height in March 2020, halfway through the semester in which this initiative took place, and as a result the university campus closed and courses moved to remote teaching; thus, many protocol changes to this study had to be implemented with little preparation. To begin with, further recruitment of student groups, which was expected to increase the sample size, was halted, and some existing groups that had begun their CVR projects reverted to traditional written assignments in order to limit additional “uncharted territory” work for instructors and students.

Although it was the intent to host focus groups with complete student teams, it was, first, difficult to reach all the students (few responded to our attempts to contact them via email) and, second, for those we were able to reach and who agreed to participate, it was difficult to find common time. Thus, the research team decided to adapt the focus group script to suit one-on-one interviews, lasting an average of 18 minutes. The research team still managed to conduct one focus group with the faculty participants, lasting 32 minutes. Both the focus group and the interviews were conducted remotely via Zoom video-conferencing software; students and faculty were awarded a \$25 Amazon gift card for providing feedback about their experiences.

### **3.5. Data Analysis**

The data collected from these four sources were qualitatively coded using grounded theory. The initial coding infrastructure was devised by one of the principal investigators through open-coding after the first reading of the data, and was refined and agreed upon by the research team. Six themes were identified, three of which (1. Necessary Resources, 2. Assignment Modification, and 3. Feedback about Technology) address program implementation, and three of which address program evaluation.

## **4. Results**

All five faculty members who were approached about implementing the initiative agreed. These instructors attended a full-day workshop in November 2019 and provided quantitative and qualitative feedback in order to improve future training workshops. A detailed description of this workshop, its outcomes, and suggested improvements are found in a complementary paper.

Of the five instructors who attended the faculty workshop and agreed to the study, only four successfully implemented CVR in their courses. Although all instructors managed to adapt an assignment, one instructor was not successful in recruiting student participants. Of the courses that implemented CVR, three were third-/fourth-year nursing courses, and one was a third-year humanities course; a total of 19 students, divided into five groups, participated. The projects were diverse in topic (pain management, patient-centered care, cultural narratives), in style (from storytelling: acting out of a constructed script, to documentary style: capturing a cultural event live), and in the level of RA involvement. The group sizes, course representation, and RA involvement (from only providing technical support to helping ideate the project) are listed in Table 1. Figures 1 and 2 show groups of students together during a CVR work session. Student projects and final deliverables were presented to colleagues in class and uploaded to a private YouTube channel. Some projects can be viewed at [CVRRICULUM Program/Examples](#). It is our team's

intent to grow this “CVR” library to help instructors (1) understand what kinds of assignments can be adapted to VR, (2) recruit interested students, and, perhaps most importantly, (3) spread understanding and share experiences from completed CVR projects with students across different departments and faculties.

Table 1. Group size and RA involved by Course.

Course	Student group size	Degree of RA involvement
NURS 3514: Development of Self as Nurse: Nurse as Leader and Agent of Change	6	Technical support (camera setup, editing) Ideation
NURS 3524: Health and Healing: Client Centred Care of Individuals and Families in Child and Mental Health Settings	4	Technical support (camera setup, editing) Ideation
NURS 4546: Global Context of Nursing	2	Technical support
CLTR 3150: Doing Culture: Narratives of Cultural Production	GroupA: 4 people GroupB: 3 people	Technical support (camera setup)
HH/NURS 2522 6.00 Health and Healing: Client-Centred Care of Individuals with Common Health Challenges	No groups formed	No active support



Figure 1: Student tests the VR equipment to better understand how films look through the HMD



Figure 2: Student group practices their script before filming in VR

#### ***4.1. Qualitative Findings***

Data from four anonymous reflections, 14 structured group observations, six one-on-one student interviews, and one focus group (including all five instructors) uncovered common experiences with program implementation. In this section, we describe and elaborate on these common themes (1. Necessary Resources, 2. Assignment Modification, 3. Feedback about Technology), providing qualitative excerpts from the various data collection methods representative of participant's feedback on each issue. Table 2 summarizes the themes and findings related to RQ1, and provides select quotations.

Table 2: Themes and select participant quotations identified through qualitative data analysis.

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Theme	Findings	Representative quotations from the data
(1) Necessary Resources	(a) Faculty workshop	"Missed part of the train-the-trainer workshop and didn't have session with [the RA] either so I had a hard time explaining it to my students"
	(b) Opportunity to experiment with technology	"A more practical opportunity to use the equipment would have been helpful and able to provide feedback to each other"
	(c) Technical support	"Without the 'tech support' it won't happen"
		"They would not be able to get a good angle/use the VR alone, I don't think they would have gotten the best result. The tech support piece was very useful"
		"It helped having [the RA] but without him, it would've been hard implementing it within course curriculum"
		"Mentorship piece needs to be built into the mix"
(2) Assignment Modification	(a) Previous CVR project examples	"Professors are not technologists so need hands-on tech support to enable implementation"
		"RA came in with PI to articulate the project. It was after PI <u>left</u> , students were overwhelmed maybe it was because of the beginning of the project. First nobody wanted to do it but second time, got the 10% response rate. To recruit more, it might be helpful if PI comes in with a VR video example. Maybe it was foreign concept. So being <u>more savvy</u> in the recruitment strategy by showing applications would be helpful."
		"Not a lot of students came forward, a lot of them were overwhelmed. It would be a lot of work if they did a VR project so they opted to write a 4-page paper instead. The PI did a great presentation, it would be helpful to also showcase student work from previous year moving forward"
		"It was easier because no paper required but it was more time-consuming. Finding time to meet, record and edit required much more time. The assignment was only 5% and we put in hours meeting before class and after class. The effort we did was more intense than writing a paper."
		"Ideally, I would have liked to spend much more time learning about the technology and doing the video editing. However, the project was only worth 5% of the final grade, so my time was limited. The part that I enjoyed most was writing the script, and re-enacting the scenario. The part that I enjoyed least was being in a rush to finish with limited time available. I would definitely recommend that my friends participate in the VR project, especially if it was a large assignment."
		"15-20% is more reasonable than 5% for the amount of work you have to do"
(3) Feedback about Technology	(b) Assignment clarity	"Students would have liked to have more information about the criteria for the assignment - what needs to be included in video vs the written part [in this case there was a reflection on the assignment to be submitted]."
		"the rubric given to students was formatted for the paper version of project not accounting for the VR hence generating some confusion. <u>However</u> everyone seemed understanding of the 'open format-ness' of the project due to its new technological nature."
		"students understand WHY they're doing this, in other words, what benefits or additional perspective VR brings to their learning experience. And that this in turn 'can help them think about the assignment required and framing their video accordingly to highlight the 'why'."
		"Skill based rather than theoretical"
	(c) Sharing the project output	"it would have been more impactful to have groups present VR photo essay and discuss their experiences but didn't get to this final oral piece in class due to COVID"
		"COVID ruined the part where she could put on the headset and be immersed. <u>Instead</u> she had to look at the video which was more like 2d representation."
(3) Feedback about Technology	(a) Ease-of-use	"Students have begun using the equipment without any assistance. They can also troubleshoot simple errors (Bluetooth connection from phone to VR headset, and Bluetooth connection from phone to 360 camera)." Another reported: "Most students are eager to use the VR headset and 360 camera. No issues were present while students were using the equipment. Beyond the basic introduction, students seemed to be using the equipment almost intuitively."
		"the headset energy saving behaviour (turn off screen when not worn) confused some people as they would see prompts to recenter their screen and be unsure what to do - once everyone got comfortable with the headsets that was no longer a problem."
		"It wasn't so bad in terms of recording. The actual recording was straight forward but when it came to upload and editing, it was difficult. They did not know how to do it"
	(b) Capturing using a static-camera	"It was challenging to find the right moment to film (as it was documenting non-controlled action) as well as having all the group and RA stay out of frame to get clean recording."
	(c) Need for explicit consent	"It was challenging to find parts of the festival that can be recorded with not too many people all willing to sign the York video/photo consent forms."
		"Something to change is the access -- a specific area dedicated to VR projects on campus. Booking in advance for a room in a lab was a process. Maybe a dedicated area and resources like props for VR would be helpful."

#### 4.1.1 Necessary Resources

Necessary Resources refers to elements that were essential to ensuring or that would be required in the future to ensure the success of such a program. The elements identified were mentioned at least once by all participating faculty and by some students.

The utility of the *Faculty Development Workshop (FDW)* was confirmed by all instructors. The one instructor was unable to attend the entire FDW or to schedule a private training session with an RA, admitted having great difficulty explaining the project and technology to her students.

While an important aspect of the FDW was the introduction to the devices, the opportunity to *experiment with technology* at greater length prior to the start of the course would prove beneficial. Although the participating instructors were given two months to try the camera and headsets before the start of the “recruiting” semester, they did not experiment with the technology, which may have affected their confidence in promoting the project and recruiting student groups. They reported several reasons, such as not having time to experiment, or its not being a priority, but only one reason can be actively addressed by the CVR team. Instructors expressed wanting more time with knowledgeable tech staff to experiment with the technology. They mentioned having insufficient understanding or training from the faculty workshop to be able to play with the equipment on their own. One instructor stated “A more practical opportunity to use the equipment would have been helpful and able to provide feedback to each other”.

Similarly, while getting acquainted with the devices during the FDW was essential, the need for continued *Technical support* throughout the semester was raised. In this pilot we hired skilled graduate students to work as RAs alongside undergraduate student groups. This proved ideal, as graduate students were flexible in meeting with undergraduate teams and could relate to them; moreover, the experience provided them unexpected benefits, such as increased appreciation for different disciplines and the cross-pollination of skills-learning (described in greater detail in the complementary manuscript). It would be possible to provide technical support through other personnel, such as the university’s IT department; however, this would mean losing the double-learning opportunity experienced by RAs (students themselves) and, further, might not be sustainable should the IT department lack the needed capacity.

Finally, having *previous CVR project examples* to share with faculty and students was mentioned as a clear way to garner interest in the program and increase recruitment. The use of novel technologies like VR in the classroom is still in its infancy, and one of the main goals of this initiative was to document the requirements for introducing VR into undergraduate curriculum and determining its potential scalability. Unfortunately, because of the initiative’s novelty, the CVR team could not draw from previous examples of the project (that were similar to what we were trying to implement) in order to clarify the experiences and deliverables to instructors and students. It was therefore expected that we would receive this feedback regarding providing previous examples, one instructor reflected, “not a lot of students came forward, a lot of them were overwhelmed. It would be a lot of work if they did a VR project so they opted to write a 4-page paper instead. The PI did a great presentation, it would be helpful to also showcase student work from previous year moving forward”.



#### 4.1.2 Assignment Modification

Assignment Modification refers to suggested changes to the CVR project to increase recruitment and to ensure greater success of the program.

The CVR project proved to be time-consuming; therefore, it was suggested to increase the *value of assignments*. As this was a pilot study, we lacked precedent for how much effort would be required to complete the student projects. We also wanted to give faculty the greatest flexibility in incorporating CVR into their existing curriculum. Thus, instructors were allowed to choose an existing assignment, and the respective credit value of that assignment, within their course. Most instructors elected to replace a 5% assignment with the CVR, which proved to be too little given the time students spent to complete the project. One student reflected: “It was easier because no paper required but it was more time-consuming. Finding time to meet, record and edit required much more time. The assignment was only 5% and we put in hours meeting before class and after class. The effort we did was more intense than writing a paper.”

*Assignment clarity* refers to mentions by faculty or student participants addressing the need for greater definition and description of the steps to be undertaken and expected output of the CVR project. Similar to the challenge of assigning an appropriate value to the assignment, the CVR team had no existing experience to draw from in terms of assignment rubrics and wanted to allow for flexibility to adapt assignments to each course and instructor. This meant that what was expected of students remained vague. One instructor remarked, “Students would have liked to have more information about the criteria for the assignment - what needs to be included in video vs the written part [in this case there was a reflection on the assignment to be submitted].” While there was an attempt to create a specific rubric with deliverables for the CVR project (this was initially a goal of the faculty workshop), we found that many instructors simply used the same grading metric for CVR submission that they used for their traditional written assignments. A participating instructor suggested that we ensure “students understand WHY they’re doing this “in other words, what benefits or additional perspective VR brings to their learning experience. And that this in turn “can help them think about the assignment required and framing their video accordingly to highlight the “why. The CVR team admits a shortcoming in this regard; while the immersive and empathetic nature of VR was well defined in the project proposal, the “benefits” were lost along the way, and the underlying motivation was not conveyed to students during the recruitment phase. There was some agreement among the instructors that skills-based rather than theoretical courses would be better suited to CVR but others also noted that having gone through it once, and with greater understanding of the process and output, they can better create opportunities for implementation in different courses. “I believe I have a better idea of the project now than I did earlier so now I can plan a better project, get more buy-in from the class and think of a lot more great projects”.

Finally, *sharing the project output* was mentioned as an important facet of the assignment. While the ability to do this during the pilot was impacted by the COVID-19 pandemic, the issues mentioned are still relevant when designing assignment criteria in order to ensure success in future iterations of the CVR program. Instructors suggested that *presenting back to the class* be a mandatory part of the assignment, and preferably



that it be *viewed through the VR headset* in order to take full advantage of the medium. A general misunderstanding was the ability to share and experience the *projects online*. As part of the project, the CVR team had created a private YouTube page to house all the student projects. Output from each completed project was uploaded to the website by an RA; however, this was not properly or sufficiently communicated to instructors.

#### 4.1.3 Feedback about Technology

Feedback about Technology refers to any mention of the ease or difficulty in learning to use the VR camera or headset, applying it to the assignment, and sharing it with others.

*Ease-of-use* of these novel devices was of initial concern for both the CVR team, and instructors however, feedback revealed that most students were comfortable operating the equipment and found the technology familiar to other information communication technologies they use in their everyday lives. RAs noted, “Most students are eager to use the VR headset and 360 camera. No issues were present while students were using the equipment. Beyond the basic introduction, students seemed to be using the equipment almost intuitively.” Even when some aspects were not as intuitive, with some practice, it appeared that students were able to learn quickly: “the headset energy saving behaviour (turn off screen when not worn) confused some people as they would see prompts to recenter their screen and be unsure what to do - once everyone got comfortable with the headsets that was no longer a problem.” It is worth noting that the Yi-360 VR camera appeared easier to use than the Oculus VR headset, and that much of the technical difficulty revolved around downloading and uploading the films to the different devices. There were also some reported challenges in connecting the Oculus GO headset to iPhone devices, a common problem when Android and iOS devices need to communicate using different protocols. The RAs said that it was a significant effort to get all the groups up and running, but that initial challenge was not related to the devices themselves but rather organizing students’ schedules to train them to use the equipment.

A limitation of the technology mentioned by one group was the *difficulty in capturing a dynamic environment with a static camera*, supported by a tripod. One student said, “It was challenging to find the right moment to film (as it was documenting non-controlled action) as well as having all the group and RA stay out of frame to get clean recording.” While the Yi camera does make it possible to capture live action, in 360 degrees, moving the lenses in space while filming would not result in a good experience, and so this limits the kinds of action and environment that are best suited. These aspects were described to faculty in their workshop but were likely not conveyed properly to students when they were designing their assignments. Other VR cameras are better suited to capturing during movement, but they are also more expensive and complex to use.

Another identified challenge related to the technology was the *need for explicit consent* for individuals who were captured on film. “It was challenging to find parts of the festival that can be recorded with not too many people all willing to sign the York video/photo consent forms.” recalled one student. Instructors and some students expressed concern about the privacy and confidentiality of individuals recorded, and the

difficulty of excluding people who did not provide consent (or for whom consent was not possible to obtain) given the 360-degree capture of the frame. The notion of consent and privacy was covered in the faculty workshop but again could have been more explicitly described to students and accompanied by tips on obtaining proper consent or on designing a recording that would not require explicit consent. One student suggested that to overcome these challenges, the university should offer dedicated recording space: “Something to change is the access -- a specific area dedicated to VR projects on campus. Booking in advance for a room in a lab was a process. Maybe a dedicated area and resources like props for VR would be helpful.” While this can be a useful resource for student groups creating their own narratives and scripts, it would still leave those “documentary” projects that capture in-situ events with the need to properly understand, respect, and collect explicit consent.

## **5. Discussion**

In the next section we address each of the issues and suggestions raised by faculty and students and describe changes we have already made to ensure the success of the CVR program and the ability to scale to additional courses across campus. Most of these challenges were surmounted by creating additional resources compiled into three documents: (1) Instructor’s Guide, (2) Student workbook, and (3) Equipment Manual, all available for download from the [CVR program website](https://www.yorku.ca/cvrprogram) (<https://www.yorku.ca/cvrprogram>).

### **5.1 Necessary Resources**

The most frequently reported critical resource was the support, both technical and sometimes conceptual, provided by the RAs. For the pilot year of this project, the university provided funding to support hiring Ras; this, however, cannot be guaranteed moving forward. Given the immense learning experience and benefits described by our RAs, we suggest that the CVR initiative be a partnership between two courses. One instructor from an undergraduate course (adapting a traditional assignment and providing their students an opportunity to complete a CVR deliverable) would partner with an instructor in a graduate-level media studies course (graduate students volunteering to help an undergraduate team for course credit). Given the intensity of the technical support provided by RAs, we suggest that graduate students earn at least 20% of their course credit by participating in this initiative. As instructors from these distinct disciplines may not know one another, or may not know of one another’s interest in participating in such an initiative, the CVR team would create a list of interested instructors across campus and share this list at the FDW as well as online on the project website. In addition, the team has created a number of complementary resources that provide step-by-step instruction in how to manage technical aspects of the project that were previously not described. We now have a detailed guide for using the VR camera, headset, and tripod; for uploading/downloading content to other devices, and for sharing content online. Content for this resource was also heavily informed by technical challenges described by instructor and student participants and observed by RAs. In the future, we can consider creating an instructional video to complement the guide.

It was apparent from feedback given directly after the faculty workshop, and then reiterated during the focus group at the conclusion of the project, that the faculty workshop was incredibly beneficial. The CVR team suggests that such a training workshop be held at least once a year to help onboard new interested

instructors, and to reach a larger audience (that may not be able to attend in person) to allow others to join remotely via web conferencing (Peisachovich et al., 2020). In the future, we suggest splitting the faculty workshop over two days, perhaps one week apart, where participating instructors are given “homework” to record using the VR camera and present back to their colleagues the following week. This will not only ensure that instructors have the opportunity to experiment themselves with the VR equipment but also highlight to the CVR team areas that need additional explanation and training. Furthermore, the act of completing a filming themselves may spark project ideas that instructors had not previously considered for their courses.

Finally, while it was not possible to share previous project examples during the pilot year, the CVR team now has at least four completed assignments, with consent to share in future years with interested instructors and students. Although the initial FDW was recorded, edited, and posted online, it would be beneficial to re-record and share future faculty workshops, as they will incorporate and address feedback given by previous participants (e.g., include updated information, refined descriptions of the tools and protocols, examples from previous semesters). We also intend to create a document with common Q&As from previous sessions that will be available on the project website.

## **5.2 Assignment Modification**

The second common theme that emerged from participant feedback was the need to modify aspects of the assignment. An important suggestion was to increase the scope of the project and the assignment weight to reflect the time required to learn and complete a CVR assignment. This would give students more time and incentive to dive deeper into VR learning and applications. After consultation with the participants, it would seem that the project should be valued between 15% and 20% of the final course grade. This information is critical to share with instructors planning to integrate the study and adapt existing assignments into a CVR deliverable. Instructors should either select assignments that carry that weight and have them adapted, or create entirely new assignments that have a matching “traditional” component worth the same percentage. Assignment clarity, or lack thereof, is a frequent criticism students raise even with traditional assignments. Given that there were no previous examples, and that the goal was to leave the adaptation of the assignments to individual instructors from diverse courses, it was expected that there would be vagueness around what is expected of students; instructors and students alike reported understanding the need for flexibility given that this was the pilot year. In the future we will address this challenge by providing example projects, together with assignment descriptions and suggested grading rubrics, as part of the how-to guidebook for participating faculty at the FDW. We will also place greater importance on completing a draft assignment description by the end of the FDW so that there is sufficient time to receive feedback from participating colleagues and the CVR team before the course start date. Of note, one instructor reported liking placing the onus of adapting the assignment on the student. We believe this could be best integrated if the CVR program were available for graduate courses (where greater initiative could be expected of students) or perhaps an opportunity were created to design a student-initiated individual project course, whereby an interested student can propose a CVR project to faculty member and can borrow equipment through the library.

Irrespective of delivery method, this pilot has highlighted several aspects that could help ensure successful design and completion of a CVR program. In order to help students, the CVR team created a modifiable workbook (template) that includes suggestions for incremental deliverables and goals to ensure that the project moves forward and adheres to necessary timelines. This workbook will be included among the resources provided to instructors at the FDW so that they can adapt and share with their students, as well as online at the project website. One aspect faculty raised was the need to share the output back with the class, preferably through the VR HMD, as that provides the most immersive experience. This recommendation is now highlighted as the final goal in the workbook and provides clear instruction for sharing the “VR film” online, in VR.

### **5.3 Feedback about Technology**

Each of the technical challenges (e.g., how to best prepare a dynamic scenario to be captured by a static camera, how to effectively plan to obtain consent) creates an opportunity for learning. In order to support this kind of learning, the team added content to the supporting documents that includes tips for thinking through appropriate venues (Instructor guide/ Student workbook), and lighting and sound implications for filming in 360 degrees (Equipment Manual). Equally important, the student workbook should outline the potential difficulties around obtaining consent and encourage students to think through and formulate alternatives and solutions ahead of facing problematic situations (e.g., include scenarios where consent has to be taken from multiple people at a public event). We expect that the more common challenges around using the technology are likely to fade with experience using the equipment.

## **6. Limitations**

While outcomes of the CVR program are promising and paint a bright future for the implementation of VR in higher education, it should be noted that recruitment for this initiative was predominantly undertaken by one specialty, nursing. Further, a purposive sampling strategy was employed and reached only a small number of eager faculty. In the future, the initiative should be explored across a larger and more diverse set of courses and students. The COVID-19 pandemic and the unexpected shifting of in-person, on-campus university courses to remote learning had a critical impact on the completion of the project and required significant adaptations to the project evaluation methodology.

## **7. Conclusion**

Despite the inevitable challenges introduced by the COVID-19 pandemic, we were able to draw interesting conclusions about the feasibility and effectiveness of the CVR program and suggest some improvements that would make the initiative sustainable and scalable in the future. This pilot proved that it is possible to incorporate VR into an existing undergraduate course, even with little preparation and minimal faculty training. The findings from our evaluation identified issues and brought specific suggestions around necessary resources, such as technical support, assignment clarity, such as appropriate grade weight/value; and technical feedback, such as specific challenges around obtaining consent. The CVR team has addressed these concerns by creating additional project resources compiled into three documents, a how-to Instructor

guide, a step-by-step Student workbook, and an updated and extended Equipment manual. Furthermore, the ability to now share completed assignments (generated from this pilot) will be extremely helpful to future participants in envisioning how VR can be implemented in diverse curricula and adapted to their specific learning objectives. The compiled resources will be made available on our CVR program website (<https://www.yorku.ca/cvrprogram>), and our team will continue to report on the results and feedback provided in subsequent implementations of the CVRRICULUM initiative.

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# **The development of a theoretical-practical model for the identification of teaching competencies in Brazilian public innovative universities**

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## **Abstract**

*This investigation aims to categorize and identify the general teaching competencies that professors who work in a Brazilian public innovative university should develop. It employs the Delphi Panel method, which allows a consensus of opinions to be reached by a group of experts. This study had eight expert participants from different fields of study. They engaged answering five rounds of instruments, that were sent them by email. After analyzing the competencies, the experts suggested agglutination between some categories and some eliminations. As a result, the competences were summarized in six categories: Digital, Internalized, Externalized, Teaching Knowledge, Technical, and Innovative. This research will serve as theoretical support for the elaboration of a theoretical-practical model for the identification of teaching competencies to work in Brazilian public innovative universities.*

**Keywords:** Teaching competencies, Innovative universities, Delphi Panel, Brazilian public universities

## **1. Introduction**

Competence is an indispensable element to add organizational value and to contribute to the success of tasks performance; it is important to develop knowledge management. Observing the skills of each employee allows the organization to build a career plan. This contributes to reducing employee turnover,

as they will feel more motivated to develop in the organization.

For Drucker (2002, p. 13, our translation), "[t]here is only one satisfactory definition of management, whether we speak of a company, a public agency or a non-profit organization: making human resources productive". Boyatzis (2004), states that the individual who knows what to do, when to do, and how to do it has a chance of obtaining better results. Professional competence in universities involves the professors' ability to articulate theoretical knowledge to their professional practice, taking into account their professional and personal experiences. This ability is developed during teacher education, which is later expanded with continuing training (Malaco, 2007). This study of the skills required in teaching, according to Vasconcelos (2010), enables professors to understand their roles and responsibilities in the teaching-learning process.

Having this in mind, this article describes an investigation that aims to categorize and identify the competencies of professors who work in Brazilian public innovative universities. The article is organized into five sections in the following fashion. Following this introduction, which describes the theme, it provides a theoretical framework on competencies and a list of competencies that a professor should have throughout his academic career, according to the integrative review of literature. In the sequence, it describes the method, followed by the results and discussion section. Finally, it presents some final considerations of the study.

## **2. Theoretical Framework**

This section presents the results of an integrative literature review, which is a method to synthesize results obtained in research on a topic or issue, in a systematic, orderly and comprehensive manner (Ercole, Melo & Alcoforado, 2014). The integrative review allows the simultaneous inclusion of experimental and non-experimental research, providing a more complete understanding of the topic, combining studies with different methodologies.

In order to carry out this integrative literature review, a search was conducted based on online databases with characteristics of internationalization and interdisciplinarity. Moreover, another criterion was the selection of databases with the highest number of peer-reviewed publications. Therefore, the review was conducted employing Scopus, Web of Science, and Education Resources Information Center.

The descriptors used in the search were "innovative university", "competence", and "human capital". They were employed in combinations of two descriptors, and searched in the articles' titles, abstracts and keywords. The first filter was related to the type of document ("Article" and "Review") and the second filter referred to the language ("English" or "Spanish"), without time restriction. The search revealed a total of 255 articles. The reading of these abstracts demonstrated that 40 articles adhere to the theme under study. Additionally, in the course of the research, other articles were added.

### **2.1 Competence: definition and purpose**

The word competence, according to Cardoso, Riccio and Albuquerque (2009, p. 366, our translation), "originates from the word *competentia*, from Latin, which means the quality of those who are able to appreciate and resolve a certain matter, to do a certain thing, with capacity, skill, aptitude and suitability".

Studies on Competence were prominent in the United States in the 1970s. They started with McClelland (1973), who published the paper “Testing for Competence rather than Intelligence”. It was the beginning of the movement on skills in the world of work. McClelland (1973) defines competence as an underlying characteristic of a person who is related to superior performance, in performing a task or in a certain situation. Several authors have provided definitions for competence.

Fleury and Fleury (2011) expand the discussion on competence. They define it as a set of knowledge, skills, and attitudes that justify high performance, where an assumption is made that the best performances are based on intelligence and personality of people. In this approach, competence is considered as a stock of resources that the individual holds. For the authors, the assessment of individual competencies is performed in relation to the set of tasks of the position or position occupied by a person (Fleury & Fleury, 2011).

Fava (2017, p. 344, our translation) understands competence as “the junction of conceptual contents with procedural sets that produce know-how, crucial to the development”. The combination of procedural content with attitudinal content generates knowledge and the disposition to act. Assembling the attitudinal and conceptual contents, a person conquers the knowledge of being and coexisting.

Dutra (2017) defines competence as a mobilization of knowledge and experiences to meet the demands and requirements of certain contexts, marked mostly by work relationships, company culture, unforeseen circumstances, and time and resource limitations.

Regarding the specific context of this investigation, the universities, authors have provided definitions for the necessary competence to be a professor: the teaching competence. According to Masetto (2003), teaching competence in a university context consists of the construction of knowledge for a changing world. For the author, the professor needs: to combine imagination and action, to search and work with new information, to use computer resources to communicate nationally and internationally, and to have the ability to build or reconstruct knowledge.

The sense of teaching competence reveals a know-how, added to theoretical knowledge, presenting skills to build such knowledge in attitudes or actions that facilitate the conduct of the teaching-learning process (Nimtz & Ciampone, 2006). Competence can be understood as the core of teaching, occupying the centrality for the success of teaching activities (Pinhel & Kurcgant, 2007).

Corrocher, Cusmano and Morrison (2009) and Pina and Tether (2016) state that innovative universities are facing challenges to produce innovations and increase their national and international impact. The most valuable assets of innovative universities are the knowledge and skills incorporated in the teaching human capital. The challenges encountered can be derived from the needs of their students, that usually cannot be met with a single course. Knowledge management aims to create knowledge and stimulate innovation, allowing the knowledge of an organization to be located, shared, formalized, improved and developed. In this way, environments are created that support knowledge sharing, the creation of innovation as well as new teaching skills.

From the above, it is possible to observe that there is no consensus on the definition of competence and there are some aspects of divergence among them. This means that the theme, both in business and academic circles, covers different concepts and dimensions, constituting a range of unconnected knowledge (Bernhardt et. al., 2005). Bearing this in mind, the next subsection presents a menu of competencies, which

was built based on the review of literature.

## 2.2 Menu of Competencies

The menu of competencies was generated from the integrative literature review and other complementary readings. The competencies a professor should have during his academic career are displayed in Table 1, along with their respective authors and year of publication.

Table 1. List of competencies with their respective authors and year

Competencies	Authors (publication)
Communicative	Lowman (2004), Greenhill (2010)
Cognitive domain	Resende (2000), Davies, Fidler and Gorbis (2011), Moore and Kearsley (2013)
Technical domain	Lima and Rocha (2012)
Facilitator (mediator)	Berge (1995), Collins and Berge (1996), Kemshal-Bell (2001), Palloff and Pratt (2002), Souza, Couto, Oliveira (2012), Moran (2013);
Knowing how to use technology	Perrenoud (1999), Zabalza (2003), Masetto (2003)
Knowing digital media	Berge (1995), Collins and Berge (1996), Kemshal-Bell (2001), Palloff and Pratt (2002), Davies, Fidler and Gorbis (2011), Stallivieri (2016)
Digital literacy	Berge (1995), Collins and Berge (1996), Kemshal-Bell (2001), Palloff and Pratt (2002), Greenhill (2010)
Using new technologies	Perrenoud (1999), Zabalza (2003), Whale (2006), Kemshal Bel (2001), Stallivieri (2016)
Analyze and evaluate systems	World Economic Forum (2018)
Having the ability to navigate complex environments	Nadai (2006)
Mastering design and programming (of technology)	World Economic Forum (2018)
Having computational, technological and digital thinking	Davies, Fidler and Gorbis (2011), World Economic Forum (2018)
Knowing tutorials (computer programs, apps, software)	Garcia et al. (2011)
Being clear in the organization of ideas	Davies, Fidler and Gorbis (2011), Moore and Kearsley (2013)
Having coherence of thoughts	Davies, Fidler and Gorbis (2011)
Differentiating teaching and learning styles	Stallivieri (2016)

Managing cognitive load	Cheetham and Chivers (1996), Paiva (2007), Davies, Fidler and Gorbis (2011), Greenhill (2010)
Organizing and directing learning situations	Perrenoud (1999)
Having analytical thinking	World Economic Forum (2018)
Having critical thinking	World Economic Forum (2018)
Reasoning logically	Davies, Fidler and Gorbis (2011), World Economic Forum (2018)
Solving complex problems	World Economic Forum (2018)
Knowing how to work with Transdisciplinarity	Davies, Fidler and Gorbis (2011)
Accessible	Lowman (2004)
Adaptable	Davies, Fidler and Gorbis (2011)
Friendly	Lowman (2004)
Attentive	Lowman (2004)
Having self-esteem	Annan (2014)
Collaborative	Friedman (1999), Korthagen (2004), Pan et al. (2009), Delaney et al. (2010), Greenhill (2010)
Understanding	Lowman (2004)
Available	Lowman (2004)
Having disposition	Pan et al (2009)
Fun	Lowman (2004)
Empathetic	Friedman (1999), Korthagen (2004), Pan et al. (2009), Delaney et al. (2010)
Encouraging	Lowman (2004)
Engaged	Francis (2011)
Enthusiastic	Lowman (2004)
Engaging	Lowman (2004)
Inspiring	Lowman (2004)
Emotional intelligence	World Economic Forum (2018)
Fair	Lowman (2004)
Motivated	Lowman (2004), Friedman (1999), Korthagen (2004), Pan et al. (2009), Delaney et al. (2010)
Patient	Lowman (2004)
Helpful	Lowman (2004)
Resilient	Annan (2014)
Respectful	Lowman (2004)
Nice	Lowman (2004)
Having social support (non-verbal	Konrath, Tarouco and Behar (2009)



communication)	
Living with interculturalism (interaction between cultures in a reciprocal way)	Davies, Fidler and Gorbis (2011)
Living in society	Resende (2000)
Establishing cross-cultural relationships (relationships or exchanges among cultures)	Davies, Fidler and Gorbis (2011)
Respectful to diversity	Annan (2014)
Working in a network	Annan (2014)
Taking risks and challenges	Zabalza (2009)
Being aware of new opportunities	Annan (2014)
Facing the ethical duties and dilemmas of teaching	Cheetham and Chivers (1996), Paiva (2007)
Having academic engagement with students	Davies, Fidler and Gorbis (2011)
Having professionalism	Annan (2014)
Having political civility	Resende (2000), Paiva (2007)
Managing his/her own academic training	Perrenoud (1999)
Learning strategies	World Economic Forum (2018)
Social intelligence	Resende (2000), Davies, Fidler and Gorbis (2011)
Leadership	Resende (2000)
Being academically disciplined	MPE BRASIL (2014)
Dealing with social influence	World Economic Forum (2018)
Responsible	Annan (2014)
Having initiative	World Economic Forum (2018)
Continuous improvement (continuous learning)	Dziekaniak (2011), World Economic Forum (2018)
Having teaching knowledge	Cheetham and Chivers (1996), Masetto (2003), Paiva (2007), Konrath, Tarouco and Behar (2009)
Having knowledge of the market	BURCH (2005)
Having knowledge of teaching roles and functions	Masetto (2003), Konrath, Tarouco and Behar (2009)
Identifying problems	MPE BRASIL (2014)
Having a worldview	Annan (2014)
Improving learning progression	Perrenoud (1999)
Have management (time, activities, ...)	Berge (1995), Collins and Berge (1996), Kemshal-Bell (2001), Palloff and Pratt (2002)
Being didactic	Friedman (1999), Resende (2000), Korthagen (2004), Pan et al. (2009), Konrath, Tarouco and

	Behar (2009), Delaney et al. (2010)
Thinking ahead of the time (future)	Aloise-Young, Graham and Hansen (1994)
Knowing how to do	Le Boterf (2003), Leme (2005), Mendes (2012), Bitencourt (2005), Fava (2017)
Master the content	Nogueira, Casa Nova and Carvalho (2012)
Being functional (practical)	Cheetham and Chivers (1996), Paiva (2007)
Being methodological	Resende (2000), Zabalza (2003)
Participate in academic administration	Perrenoud (1999)
Being a researcher	Pachane and Pereira (2004)
Having self-management	Berestova (2009)
Talent	Martín-de-Castro (2011)
Flexible	Moore and Kearsley (2013)
Creative	Moran (2013)
Innovative thinking	World Economic Forum (2018)
Integrative thinking	Davies, Fidler and Gorbis (2011)
Problem solving	Hargreaves (2004), World Economic Forum (2018)
Having a digital role (understand, use and learn digital technologies)	Garcia et al. (2011)
Having the ability to learn to learn	Hargreaves (2004)
Being able to analyze data	Davies, Fidler and Gorbis (2011)
Having the ability to collaborate	Perrenoud (1999), Annan (2014)
Ability to work in network	Davies, Fidler and Gorbis (2011)
Curiosity	Moran (2013)
Systemic view	Rosenau and Trevisan (2007)
Being able to observe	Perrenoud (1999)
Proficiency in a foreign language (writing, speaking, listening, and reading)	Stallivieri (2016), Van Der Werf (2018)

The general competencies, indicated by the literature, reveal what a teacher should “be” or “have” throughout his academic career. These competencies must be aligned with institutional demands. The professor must be prepared for a world where instantaneousness can bring information both fast and uncertain, leaving the professor to filter, select and expand knowledge.

### 3. Materials and Methods

The objective of this investigation is to categorize and identify the competencies of professors who work in Brazilian public innovative universities. In order to fulfil this objective, the Delphi Panel method was employed.

The Delphi Panel is defined as “a method to structure a collective communication process, so that it

is effective, by allowing a group of individuals, as a whole, to deal with a complex problem” (Linstone & Turoff, 2002, p. 3, our translation). Its objective is to obtain consensus of the opinion of a group of experts in an objective way through a series of rounds, questionnaires and feedback. Delphi is a research technique widely used in several areas of knowledge, such as economics, business, social sciences, and education. Its main advantage is obtaining consensus in face of a given reality (Marques & Freitas, 2018). In the present work, due to the pandemic, the research was carried out via Internet, where the specialists accessed the menu of skills shared by Google Drive, and present their contributions and considerations within a week.

The Delphi Panel is characterized by respecting the anonymity and heterogeneity of specialists. The specialists may be from different areas of training, as their contributions will be diversified, depending on the worldview (Skulmoski, Hartman & Krahn, 2007). It is also necessary to respect seven steps to guarantee the success of the process; they are described in the sequence.

Step one: Choosing a Mediator/Facilitator. The literature recommends using a mediator, other than the researcher himself, due to the neutrality stance in relation to the objectives and results of the project. The mediator/facilitator must be familiar with investigative research, data collection and treatment (Haughey, 2010). However, in this research, the mediator/facilitator was the main researcher due to her academic background and the reliable experience with research, data collection and analysis.

Step two: Defining the objectives. What is the problem or subject that do you want to understand? It is crucial to provide a clear and comprehensive definition to ensure that the experts understand exactly what is being commented on. The objective, in this research, is to identify the general competencies of teachers to work in Brazilian public innovative universities.

Step three: Selecting the specialists. The selection of specialists is essential, and, according to Powell (2003), heterogeneous groups tend to produce solutions of higher quality and acceptance. It is important that the panel is balanced between impartiality and interest in the subject and that it is varied in terms of experience, areas of expertise and perspectives in relation to the problem. The chosen experts must be committed to the whole process and must belong to the context of Brazilian public innovative universities, which are committed and involved with innovation. It is also relevant to provide the specialists with detailed information on what the study consists of and what will be demanded from them until the final round of the panel (Marques & Freitas, 2018).

Step four: Inviting the specialists. An initial invitation letter should be sent to specialists via e-mail, with details of the study and inquiring their availability to participate in the Delphi Panel. Twenty e-mails were sent, and five initial acceptances were obtained. One week after the first invitation, the same e-mail was resent to those who had not yet replied the previous e-mail. This resulted in three more participants. As a result, a total of eight specialists accepted to be part in this investigation. They have the following academic background: computer science; publicity and advertising, business and marketing, psychology, and business and social communication.

Step five: Applying the instrument. The specialists, anonymously and individually, answered the instrument. Once the specialists had been defined, a Skype meeting was scheduled to explain the purpose of Delphi and how they would make contributions in the instrument, which was sent in spreadsheet format, as shown in Figure 1.

	A	B	C	D	E	F	G	H
1			Mark an X					
2	Category of the competencies	Meaning on the teaching context	Totally agree	Partially agree	Indifferent	Partially disagree	Totally disagree	If you disagree, copy it and paste in this column and in the appropriate Subcategory
3								
4								

Figure 1. Delphi panel layout applied to specialists

The application of the online questionnaire minimized the time for conducting the research and data tabulation. It also allowed a faster feedback, avoiding the loss of the specialists' interest. Responses were consolidated and distributed to specialists. These steps (rounds) are repeated until consensus is reached on the solution.

The forwarded spreadsheet presented nine columns (Figure 1), with the first column presenting the categories of competencies: Distance Learning, Technological; Cognitive, Emotional, Social; Attitudinal, Behavioral; Teaching Knowledge; Techniques and Innovators. The second column presents the definition or meaning of the teaching competence that must be analyzed. The third column shows the competencies to be analyzed, which can be classified in any category, according to the reflections made by the specialists. In the sequence, from the fourth to the eight columns, the levels of agreement are presented, starting from left to right in the following order: totally agree, partially agree, indifferent, partially disagree, totally disagree.

The specialist should evaluate the competence and mark an "X" in one of the five levels of agreement. After this procedure, if the specialist chooses to check "partially disagree" or "totally disagree", s/he should copy and paste the competency in the 9th column, indicating the place where s/he thinks the competence belongs. Whenever the specialist indicates a disagreement, that competence will go to another category, with nine options, and it may be in more than one category, if necessary.

Step six: Achieving a consensus on the rounds. A round is each of the successive questionnaires/instruments presented to the group to be evaluated. The question of the rounds of instruments ends when the levels of stability and consensus in the answers are reached. There is consensus, in general terms, when there is low divergence in the distribution of responses to a given item (Osborne et. al., 2003). The absence of new contributions and little change in the panel's responses between rounds is an indication of its closure. This research ended the process after five rounds. To illustrate, the Delphi Panel cycle process, Figure 2 shows the overview from the beginning to the end of the five cycles.

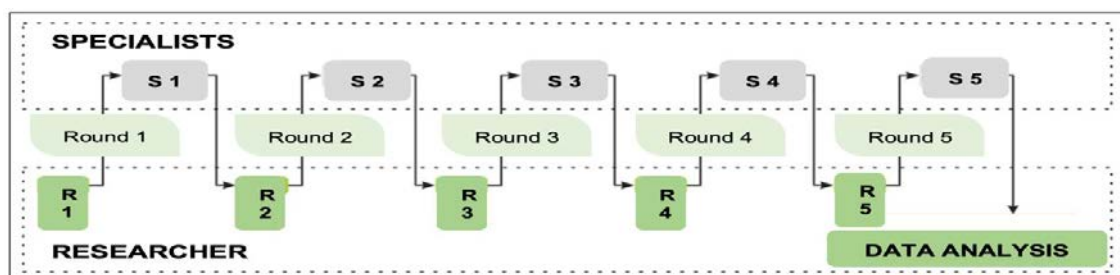


Figure 2. Overview of the Delphi Panel Process

S = The week the specialists reflect about and answered the instrument.

R = The moment that the researcher prepared the instrument for next round.

Step seven: Analyzing the data. Some authors, such as Cunha (2007) and Marques and Freitas (2018), use statistical tests to look for relationships between responses and between responses from subgroups of specialists. This investigation employed the graphical representation of columns, which, according to Loch (2006), is a graph elaborated from the Cartesian plane; it is simple and excellent to use when comparing variables.

#### 4. Results and Discussion

To start with, the specialists suggested to combine the Distance Learning Competence and the Technological Competence categories into the Digital Competence category. Therefore, the competencies that were categorized as Digital, according to the experts, are the following: having management (time, activities); communicative; having cognitive domain; having technical mastery; being a facilitator (mediator); using digital technologies and media; having social support (non-verbal communication); having digital literacy (chat, blog, email, forum); using new technologies; analyzing and evaluating systems; having the ability to navigate complex environments; mastering design and programming (of technology); having computational, technological and digital thinking; working in a network; and knowing tutorials (computer programs, Apps, software).

As displayed in Figure 3, there is a consensus in both categories. Regarding Distance Education, 75% of the specialists totally agree and 25% partially agree. In relation to Technological, 87.5% of the specialists totally agree and 12.5% partially agree.

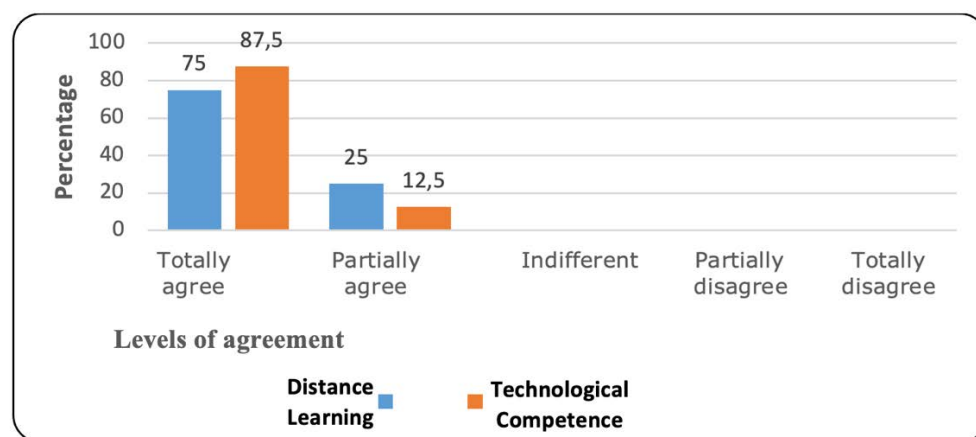


Figure 3. Experts' level of agreement on the categories Distance Learning and Technological

Concerning the categories of Cognitive Competence, Emotional Competence, and Social Competence, the specialists suggested that the three could be grouped as Internalized Competence. Thus, the competencies that were categorized as Internalized, according to the experts, are the following: having clarity in the organization of ideas; having coherence of thoughts; differentiating teaching and learning styles; managing cognitive load; organizing and directing learning situations; thinking ahead of the time (future); having analytical thinking; having critical thinking; having innovative thinking; reasoning logically; solving complex problems; knowing how to work with transdisciplinarity; being accessible;

being adaptable; being friendly; being considerate; being a collaborator; being understanding; being available; having disposition; being funny; empathizing; being engaged; being funny; having enthusiasm; being engaging; having flexibility; being inspiring; having emotional intelligence; being fair; being motivated; being patient; being helpful; having resilience; being respectful; being nice; living with interculturalism (interaction between cultures in a reciprocal way); having political civility; coexisting in society; establishing cross-cultural relationships (relationships or exchanges between cultures); and respecting diversity.

Figure 4 shows experts' level of agreement on the three categories. For the Cognitive Competence, 75% of the experts totally agree, 12.5% partially agree and 12.5% partially disagree. With reference to the Emotional Competencies, 75% of the experts totally agree, 12.5% partially agree and 12.5% are indifferent. Finally, for the Social Competence 87.5% of the experts totally agree and 12.5% of them are indifferent.

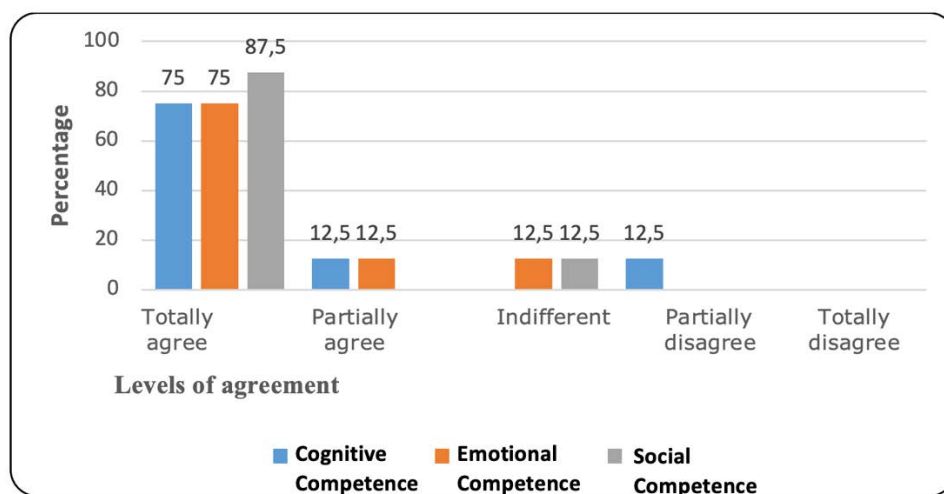


Figure 4. Experts' level of agreement on the categories Cognitive Competence, Emotional Competence, and Social Competence

In the sequence, the specialists suggested to combine the Behavioral Competence and the Attitudinal Competence categories into a category called Externalized Competence. The competencies that were categorized as Externalized, according to the experts are: taking risks and challenges; being aware of new opportunities; being academically disciplined; facing the duties and ethical dilemmas of teaching; having academic engagement with students; having professionalism; knowing how to do; managing his/her own academic training; having learning strategies; having social intelligence; having leadership; dealing with social influence; being responsible; and having initiative.

Figure 5 displays the suitable consensus among the specialists in both categories. For the Behavioral category, 75% of the experts totally agree and 25% partially agree; while for the Attitudinal category 87.5% of the experts totally agree and 12.5% are indifferent.



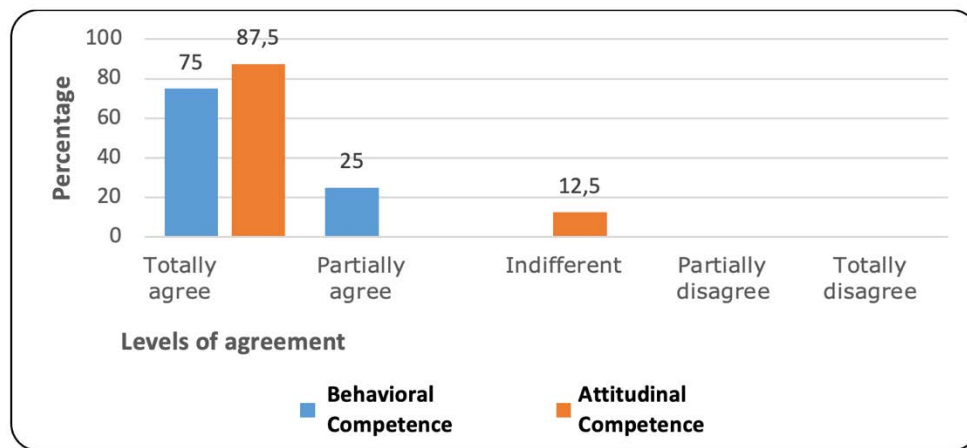


Figure 5. Experts' level of agreement on the categories Behavioral Competence and Attitudinal Competence

Similarly, Figure 6 also demonstrates the specialists' consensus, this time regarding the Teaching Knowledge category: 75% of the experts totally agree, 12.5% partially agree and 12.5 partially disagree. However, for this category, they did not suggest any grouping with other category. The competencies that were categorized as Teaching Knowledge, according to the experts, are the following: continually improving (continuous learning); having teaching knowledge; having knowledge of the market; having knowledge of teaching roles and functions; identifying problems; and having a worldview.

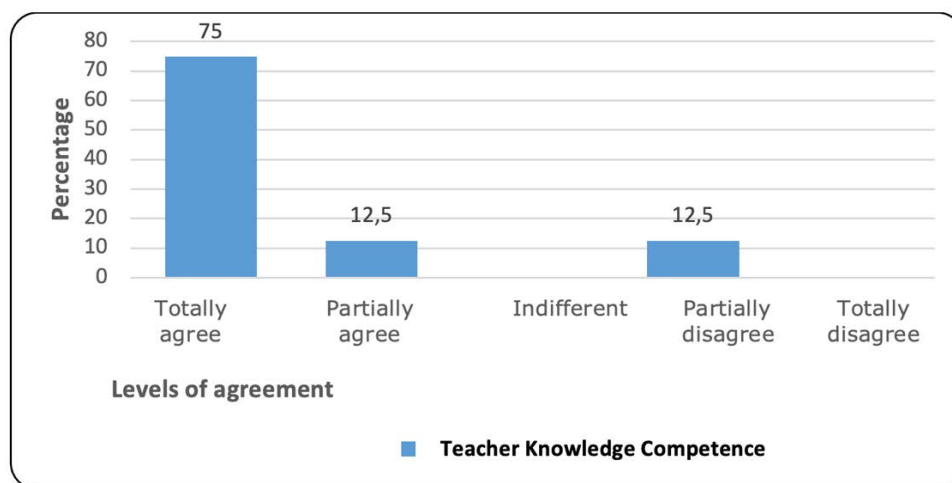


Figure 6. Experts' level of agreement on the Teacher Knowledge Competence category

Analogously to the former category, the Technical Competence category was not grouped to any other category. The experts arrived to a consensus with 75% of them totally agreeing and 25% partially agreeing (Figure 7). The competencies that were categorized as Technical Competence, considering the experts' suggestions, are as follows: managing the progression of learning; didactic-pedagogical; having content domain; being functional (practical); being methodological; participating in academic administration; being a researcher; and having language proficiency.

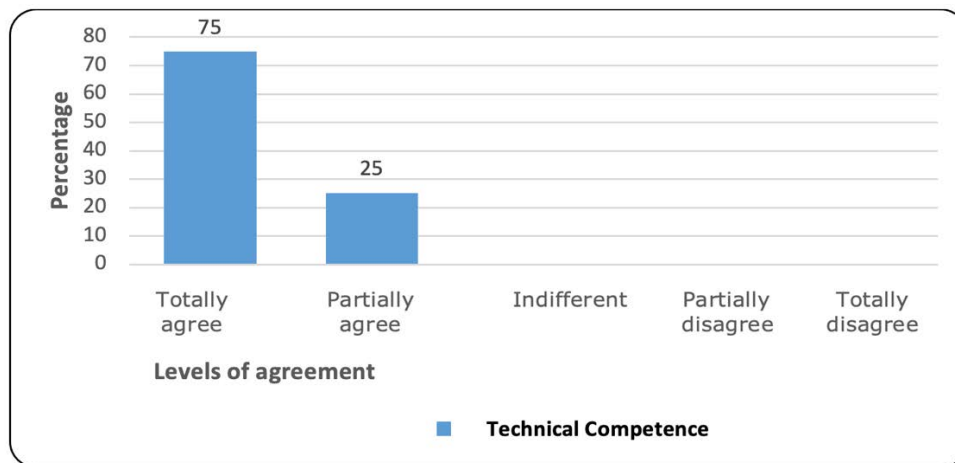


Figure 7. Experts' level of agreement on the Technical Competence category

Again, no further modifications concerning grouping of categories were suggested for the category of Innovative Competence. As exhibited in Figure 8, consensus was reached among the experts with 75% of them totally agreeing, 12.5% partially agreeing and 12.5% being indifferent. The following competencies were categorized under the Innovative Competence category, according to the experts' suggestions: having self-esteem; having self-management; having talent; having creativity; and having networking.

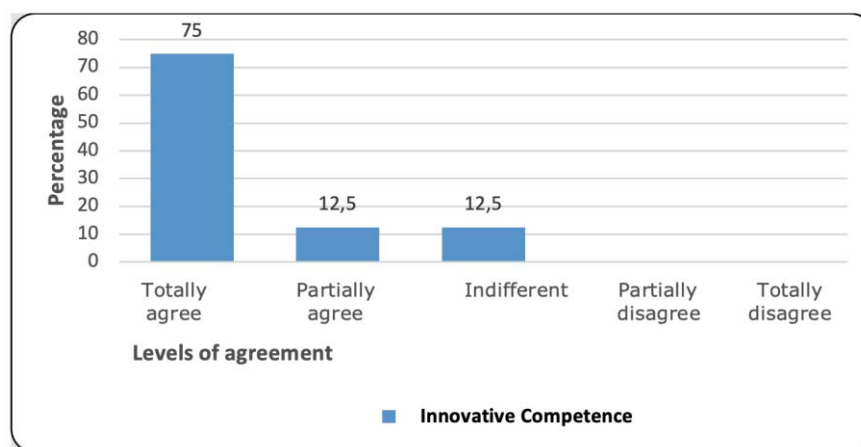


Figure 8. Experts' level of agreement on the Innovative Competence category

From the fourth to the fifth rounds, the minimum 80% consensus index was reached for all categories, since minimal inferences were made in the instrument. However, unanimously, the experts pointed out the need to remove the following skills: “being funny”, for not being in the context of the study and for not falling into any of the ten categories; “having management skills”, because there is another competence with the same meaning (“having self-management”); and “competency management process”, because it represents an “organizational competence”, which is not the focus of the research. Moreover, they suggested the modification of the naming of the “Proficiency in a foreign language (writing, speaking, listening, and reading)” competence to simply “Proficiency in a foreign language”, eliminating the specificities of the language skills.

Figure 9 shows the final result after all the rounds of the Delphi Panel with the agglutinations suggested by the experts. The Figure represents the professor in the center with the six categories of competencies: digital, internalized, externalized, teaching knowledge, technical and innovative. These competencies are inserted in the context of the knowledge triangle: teaching, research and innovation (represented in blue gradient). Additionally, in the external part (represented in orange), there is a theoretical contribution by four pillars: knowledge society; knowledge-intensive organizations; innovative Brazilian universities; and teaching human capital.

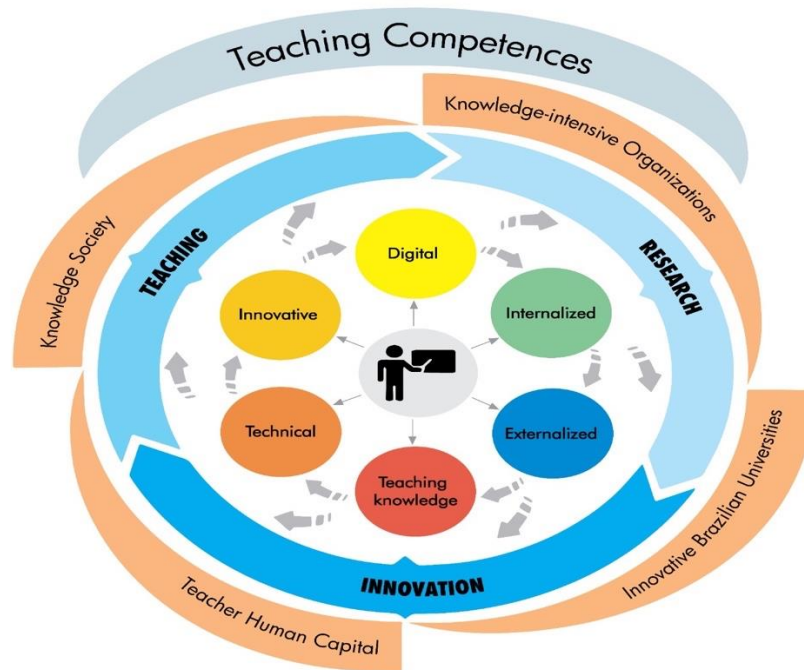


Figure 9. The six categories of Teaching Competencies

These results reveal that the categories and competencies, evaluated by Brazilian specialists, having in mind a teaching staff to work in a Brazilian public innovative university, are aligned with the reasoning of authors from other parts of the world. To exemplify, Baek et. al. (2020) have built a framework of teaching competency for professors in the future society, based on theoretical arguments. They suggest eight competencies organized into three categories: Change Responding Competency (active adaptation, field affinity); Innovation Promotion Competency (organization value realization, active participation); and Instructional Competency (instructional design, content knowledge, pedagogical knowledge, technological knowledge).

Moreover, the categories Digital Competence, Innovative Competence, and Technical Competence represent a shift on teaching skills. In this era of ubiquitous learning, teachers have to be able to select, organize, and mediate knowledge rather than transmitting. In this light of thought, Huda et. al. (2017) highlight the importance of exploring the adapting teaching competencies in the Big Data era. When discussing the development of technology skills, the authors state that "performing the professional standard in such activities to promote the improvement of knowledge, skills and competence becomes one of the main ultimate factors which affect the teaching process" (Huda et. al., 2017, p. 78, our translation).

Finally, the organization of the competencies into these categories reveals that the teacher education

programs need to take these results into account when building curricula, having in mind the formation of teachers for the new technological era. A study conducted by Bhargava and Pathy (2011) on the perception of student teachers about what would be the ideal teaching competencies revealed that technology savvy was not placed among the higher rank of competencies. The authors emphasize that "[t]eachers have to be technology savvy so that modern technology can find entrance in classroom and can be exploited for the benefit of the learners" (Bhargava and Pathy, 2011, p. 80, our translation). Therefore, it is necessary to rethink the curricula of teacher education programs.

## 5. Final Considerations

This article reports the first part of a large research that aims to categorize and identify the competencies of professors who work in Brazilian public innovative universities. After the application of five rounds of the Delphi Panel Method, the specialist participants arrived to the minimum 80% consensus index and grouped ninety competencies as subcategories of analysis into the following six categories of competencies: digital, internalized, externalized, teaching knowledge, technical, and innovative. These categories are supposed to represent the competencies that a professor has to develop in order to work at an innovative university.

These results will be used for the next stages of this research. On the second stage, these ninety competencies with their respective categories will be tested with specialists from Brazilian public innovative universities, who are the specialists involved directly or indirectly with teaching and innovation. On the third stage, after receiving professors' answers, 60 propositions will be elaborated and stratified into six categories with ten propositions each. The competencies that present the highest percentage of importance will serve as a central theme in the elaboration of each proposition, which represent everyday teaching situations.

The 60 propositions will constitute a model, which aims to identify the teaching competencies to work in a Brazilian public innovative university. The proposed model is intended to facilitate the academic management process, providing ways to map and diagnose which are the strong competencies and/or weaknesses of the teaching staff of an institution, so that the appropriate guidance could be developed, according to the institutions' authentic needs.

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## **Fatigue design in reinforced concrete bridges according to Brazilian code**

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### **Abstract**

*There has been an increase in the flow of freight vehicles commuting on Brazilian highways. Then, special attention to the structural performance of bridges regarding the fatigue in beams is needed. Brazil has neither normative metrology to study real data flow of vehicles, nor specific fatigue load train models and coefficients to the analysis and design of road bridges. The same load train that is used for general dimensioning, TB 450, is used for the fatigue verification. Hence, this work aims to verify if the current TB 450 is representative of the freight heavy vehicles with 2 to 9 axles concerning the effects of fatigue in the longitudinal reinforcement of beams of theoretical reinforced concrete bridges with two, three, and five beams. This verification is performed analyzing the stress variations found in the longitudinal reinforcement of vehicles with 2 to 9 axles and the TB 450. Based on the results, the longitudinal steel reinforcement was more susceptible to fatigue's effects. Freight vehicles with 5, 6, 8 and 9 axles presented the most significant stress, therefore, they tend to cause more deleterious effects. Hence, the adoption of a Brazilian normative fatigue specific load train and coefficients is necessary to analyze pre-existing road bridges and design new ones most accurately.*

**Keywords:** Fatigue; Longitudinal Reinforcement; Reinforced Concrete Bridges; Stress Variations; Brazilian Normative Load Train;

## **1. Introduction**

Currently, Brazil presents road modal as the predominant one. According to the Brazilian National Transport Confederation (CNT, 2020), road freight transport corresponds to 61.1% of the total. This fact has a significant impact on Brazilian bridges and viaducts. Among the structural problems to which these structures are susceptible, fatigue needs to be highlighted (Pimentel, Bruhwiler e Figueiras, 2008; Baroni, Silva Filho, Gastal, 2009) because the variability and the regime of live loads make bridges and viaducts more prone to suffer from this phenomenon.

According to Nowak and Fischer, (2016), the traffic infrastructure guarantees not only greater economic efficiency, but also allows people to get around well, thus contributing to the development and wealth of any country. In this context, bridges play an important role due to its responsible for crossing obstacles and connecting places (Gonzalez et al., 2019).

Researchers around the world have been conducting studies about the phenomenon of fatigue in road bridges and viaducts (Pimentel, Bruhwiler e Figueiras, 2008; Baroni, 2010; Pircher et al. 2011; Albuquerque, Pfeil, 2012; Zhang, Xin, Cui, 2012; Osumaje et al. 2016; Junges, 2017; Deng, Yan, 2018; Braz et al. 2018, LU et al., 2017; Liu, Zhou, 2018; Lou; Nassif; Su, 2017; Alencar et al., 2018; Mascarenhas, Carvalho, 2019, Hassen, 2020, Pillai, Talukdar, 2020). Those studies are justified by the relevance of these structures in the flow of people, products and goods; the high age of the bridges and viaducts; and the heterogeneity of freight vehicles that commute in railways.

The American Code LRFD Bridge design specifications (AASHTO, 2015), defines fatigue as "a phenomenon of material failure caused by repeated applications of a load. When applied infrequently, these loads would cause no undesirable effects, but when applied repeatedly, they can lead to failure" (AASHTO, 2015).

When the fatigue is analyzed, certain concepts and variables are relevant. The fatigue process in the longitudinal reinforcement of beams is a function of the dead loads and vehicles commuting (the live loads), the type of reinforcement used, and the stress variations.

In Brazil, there are two Codes with instructions and guidelines about the design and dimensioning of concrete bridges and viaducts, the ABNT NBR 7188:2013, "Road and pedestrian live loads on bridges, viaducts, footbridges and other structures" (ABNT, 2013) and the ABNT NBR 6118:2014, "Design of concrete structures – procedure" (ABNT, 2014).

Due to the variability and the regimen of occurrence of live loads, both national and international codes use different live load models to the design of bridges and viaducts. The current ABNT NBR 7188:2013 presents the vehicle called TB 450, with six wheels and a total weight of 450 kN, as the current normative live load model.

International codes for bridges such as the European, "Eurocode 1: Actions on Structures – Part 2: Traffic Loads on Bridges" (2002), American, "AASHTO LRFD Bridge Design Specifications" (AASHTO, 2015) and the Chinese, "Code for design of highway reinforced concrete and prestressed concrete bridges and culverts" (2004) have particular live load model vehicles and specific coefficients for the analysis and design of bridges on the aspect of fatigue. However, Brazil has neither specific load train models nor coefficients to the analyzes and designs of road bridges and viaducts under fatigue. The same load train

that is used for general dimensioning is used for fatigue verification. Also, the Brazilian bridge and viaduct codes have neither presented instructions nor methodologies on how to investigate, analyze, and design any bridges using the data from the real flow of freight vehicles.

This issue can put the Brazilian bridge codes at a disadvantage in terms of performance and safety of the bridges, compared to international ones. According to Braz et al. (2018), regarding the fatigue design and its effects in the reinforcement, the Brazilian code has shown to be less conservative than the European one. Furthermore, the authors (2018) advocate that it occurs because the European code has a rigor, presenting both specific coefficients and load train vehicles to design, and it has a unique value of fatigue resistance to all diameters of the steel reinforcement bars.

Carneiro and Bittencourt (2018) state that in the analysis of existing bridges, the Brazilian bridge codes lack the dynamic analysis presented in the European code, and specific coefficients of impact presented in the code of United States. This statement converges to what is explained by Stucchi and Luchi (2015), who remarks that the load train models used in Brazilian bridge standards are just copies of German standards, and there is no considerable effort to present "a genuine live load model born in Brazilian lands".

Thus, it is imperative to continuously check if the current Brazilian normative load model is representative to be used in the design of new bridges and viaducts, and the structural recovery of ancient ones, regarding the fatigue phenomenon, given the current traffic composition on the Brazilian highways.

### ***1.1 Objectives***

This work aims to analyze whether the Brazilian normative live load model, TB 450, can represent the flow of real heavy vehicles regarding the effects of fatigue on longitudinal reinforcement in reinforced concrete beams of bridges. Theoretical bridge models were designed, and road freight vehicles with 2 to 9 axles were used. Such verification is performed analyzing the calculated stress variations found in the longitudinal reinforcement due to the vehicles with 2 to 9 axles and the TB 450.

### ***1.2 Justifications***

The annual number and weight of freight vehicles have increased around the world (Pircher et al. 2011; Han et al. 2015; Deng, Wang, Yu, 2016; Han et al. 2017) and on Brazilian highways (Mascarenhas, Carvalho, 2019; CNT, 2019; Sindipeças, 2018). Regarding the road traffic in Brazil, since 1990, the circulating fleet of trucks has shown significant growth. Data on the number of freight vehicles from two different highways in the state of São Paulo in Brazil, collected from toll collection points (TCP) demonstrate this. TCP 01, which is based in the city of Limeira, had an increase of 7.68% between 2009 and 2017. TCP 02, based in the city of Valinhos, had an increase of 8.68% in the traffic of freight vehicles. TCP 01 and TCP 02 had significant growth in the number of vehicles with 5 to 9 axles since 2014, as shown in figure XX (a) and (b), respectively.



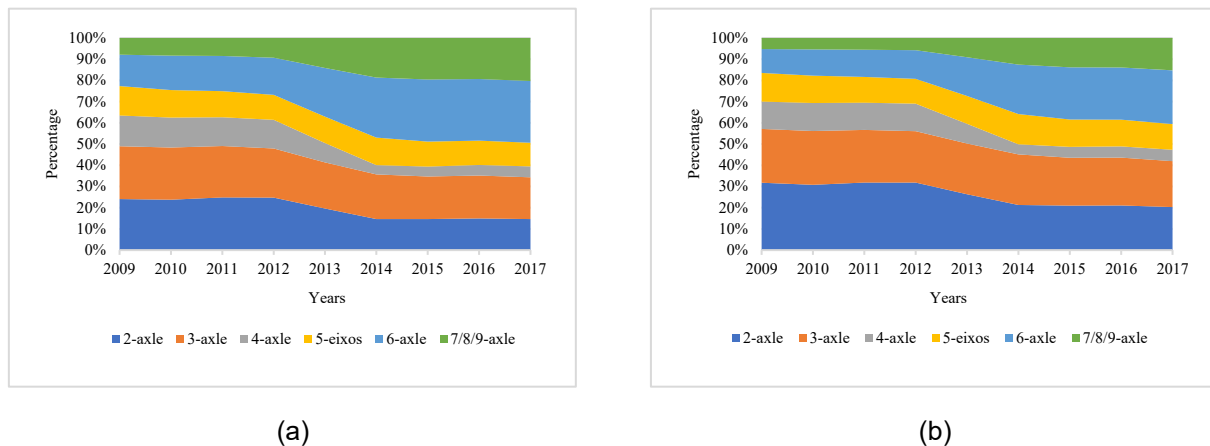


Figure 1 – Vehicle percentages

Jang and Mohammadi (2017) claim that the damage related to fatigue can be more critical in older bridges since they were designed and built using normative load models established for a lower volume of truck traffic than the one on highways currently. Brazil has a considerable number of bridges and viaducts, and most of them were designed using previous live load models. Brazilian authorities and governmental bureaus do not have a clear understanding and sufficient information about the real and current situation of these structures (Mascarenhas, Carvalho, Vítório, 2019).

Rossigali et al. (2015) point out that the current Brazilian live load model to design bridges (ABNT, 2013) does not represent the current traffic effects properly, and it can be in certain situations against security.

Maintenance of ancient and current railway bridges require that they can support more gigantic traffic volumes and higher traffic loads and train speeds (Pimentel, Bruhwiler e Figueiras, 2008). Hence, studies and analyzes, such as the one carried in this work, are necessary to provide the design of new bridges most economically and safely in terms of design and service life, and to those existing bridges, studies like this one are necessary to analyze the structures fatigue safety.

The frequent traffic of heavy vehicles causes problems in the load-carrying efficiency of bridges and fatigue damage, and Deng and Yan (2018) state that those issues are commonly ignored. This negligence can generate severe consequences since the dynamic actions (live loads) that act on bridges and viaducts can increase the internal failures or even contribute to the propagation of cracks and fractures Leitão et al. (2011), which may cause them to collapse. This statement converges to the conclusions presented by Osumeje et al. (2016), who explain that the deleterious fatigue effects in beams of reinforced concrete bridges are a grave issue regarding the durability; thus, it cannot overlook.

The mechanical behavior of reinforced concrete elements is linked to the behavior of the reinforcement steel. Then, the rupture of the element is associated with the rupture of the reinforcement, which most often occurs under flexure. Thus, the failure in the steel reinforcement due to fatigue deserves special care and attention.

## 2. Fatigue according to the Brazilian Code NBR 6118:2014

The phenomenon of fatigue is related to "repeated dynamic actions" under a structural member, and those actions cause "progressive and permanent modifications of the internal structure of a material subject to

the oscillation of tensions resulting from these actions" (ABNT, 2014). Dineshkumar and Ramkumar (2020) explain that reinforced concrete structures were made to handle static loads, but in the practice, those structures are continuously under cyclic loads, such as fatigue.

There are different methodologies to analyze the effect of fatigue on materials, among them the Paris-Erdoga Law, Mechanics Fracture, and the principle or mechanics of Cumulative Damage, or Palmgren-Miner rule (Brighenti, Carpinteri, Corbari, 2013). Keerthana and Chandra Kishen (2018) highlight the importance of the last two approaches when stating that they have been widely used by the scientific community to study the fatigue behavior of structures.

The principle of Cumulative Damage was chosen to be used to study the stress variations. This approach was adopted because in bridge fatigue non-uniform stress variations occur; it is recommended to a reduced number of structural members, such as beams; it has mathematical rigor, given the absence of conversion and simplification formulas; and it has been used by several authors in the national and international literature (Pimentel, Bruhwiler, Figueiras, 2008; Santos, Pfeil, 2014; Freitas, 2014; Zhang, Xin, Cui, 2012; Wang et al., 2015; Mascarenhas, Carvalho, 2019; Hassen, 2020).

As stated in the introduction, the stress variation is one of the most critical aspects when the fatigue analyses are carried out in beams of reinforced concrete bridges. Then, the verification of the TB 450 to fatigue is performed by comparing, in each theoretical model of bridge studied, the TB 450's stress variation  $\Delta\sigma$  of the longitudinal reinforcement with the variations obtained for the real vehicles from 2 to 6 axles.

Before calculating the stress variation, it is necessary to determine both maximum and minimum stresses in the reinforcement. To calculate the stress, first, it is necessary to determine the bending moment in the middle of the span of the beams. Then, in order to do that, the software Ftool (Two-dimensional Frame Analysis Tool) was used. Once this was done, it was necessary to perform the combination of these moments following the recommendations of ABNT NBR 6118:2014 (ABNT, 2014).

The bending moments in the middle of the span in each beam from TB 450 and vehicles of 2 to 9 axles were increased by the Brazilian normative coefficients (Equation 1): Vertical impact coefficient (CIV), the number of traffic lanes coefficient (CNF) and the additional impact coefficient (CIA); the initials stand for the names in Brazilian Portuguese (ABNT, 2013). In this paper, they were called by Weighting Coefficient of Vertical Live Loads ( $WCVL = CIV.CNF.CIA$ ), and the values change according to the bridge span. Bridge with 10.0, 15.0 and 20.0 m have WCVL equal to 1.35, 1.33 and 1.27, respectively.

$$M_{qk} = WCVL.M_q \quad (1)$$

ABNT NBR 6118:2014 (ABNT, 2014) establishes that the verification of fatigue in bridges is done by determining the frequent combination of actions, and the process of Cumulative Damage can be used for the fatigue analyses and estimation in beams of bridges. Then, the frequent combination of the maximum design normative moment to the TB 450 is given by Equation 2, and to the real vehicles of 2 to 9 axles is given by Equation 3:

$$M_{d,max\_TB450} = \sum_{i=1}^m M_{gik} + \psi_1.M_{qk} \quad (2)$$

$$M_{max\_axles} = \left( \sum_{i=1}^m M_{gik} + .M_{q1k} \right) \quad (3)$$

Where:  $M_{d,max\_TB450}$  and  $M_{d,max\_axles}$  are the design value of the maximum bending moment in the combinations to the Service Limit State to the TB 450 and the vehicles with 2 to 9 axles, respectively;  $M_{gik}$  are the dead loads;  $M_{qk}$  are the live loads;  $\psi_1$  is the frequent combination reduction factor, being equal to 0.5 for beams.

Moreover, the minimum design normative moment to all vehicles is given by Equation 4:

$$M_{d,min} = \sum_{i=1}^m M_{gik} \quad (4)$$

Where:  $M_{d,min}$  is the design value of the minimum bending moment in the combinations to the Service Limit State.

Once both maximum and minimum design moments are determined, the maximum and minimum stress in the reinforcement can be calculated by the following Equations 5 and 6, respectively:

$$\sigma_{s,max} = \alpha_E \cdot \frac{M_{d,max} \cdot x_i}{I_{II}} \quad (5)$$

$$\sigma_{s,min} = \alpha_E \cdot \frac{M_{d,min} \cdot x_i}{I_{II}} \quad (6)$$

$\sigma_{s,max}$  is the maximum stress in the reinforcement;  $\sigma_{s,min}$  is the minimum stress in the reinforcement;  $x_i$  is the distance from the neutral axis until the inferior surface;  $\alpha_E$  is the quotient of the elasticity modules of reinforcement and concrete;  $I_{II}$  is the moment of inertia at Concrete Stage II.

Hence, stress variations in the steel reinforcement can be calculated using the following Equation 7:

$$\Delta\sigma = \sigma_{max} - \sigma_{min} \quad (7)$$

Since this paper uses symmetric "T" beams in all bridge models, Figure 2 presents the "T" beam used and a generic stress distribution, representing the steel reinforcement stress variation, and the maximum and minimum ones.

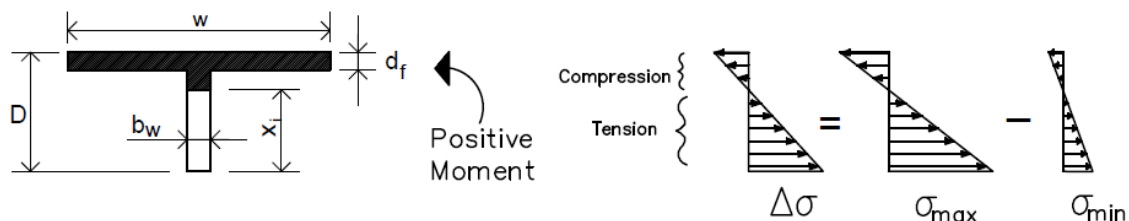


Figure 2 – Generic stress distribution in the studied "T" beam

Therefore, in this work, the TB 450 was considered representative of the real vehicles that commute on the Brazilian highways here analyzed in terms of fatigue if the stresses variations calculated for these real vehicles were smaller than those found for the TB 450. Figure 3 summarizes these considerations.

TB 450 was considered verified if  $\Delta\sigma_{TB450} > \Delta\sigma_{vehicles\_n\_axles}$

TB 450 was considered not verified if  $\Delta\sigma_{TB450} < \Delta\sigma_{vehicles\_n\_axles}$

Figure 3 – Considerations to validate TB 450

n represents the analyzed vehicle according to their numbers of axles, from 2 to 9.

In addition to that, the ABNT NBR 6118:2014 (ABNT, 2014) establishes that the steel reinforcement must be verified regarding the fatigue phenomenon. According to the Brazilian Code, this verification is satisfied if the maximum stress variation calculated,  $\Delta\sigma$ , for the combination of frequent loads satisfies Equation 8:

$$\gamma_f \cdot \Delta\sigma \leq \Delta f_{sd, fad} \quad (8)$$

$\gamma_f$  is the coefficient for unfavorable loads, and the case of reinforced concrete bridge beams it is equal to 1.0;  $\Delta f_{sd, fad}$  is the maximum normative stress variation, in MPa, according to the steel reinforcement bar diameter, in this case, it is equal to 17.5 kN/cm<sup>2</sup>.

Based on that, the steel reinforcement area must be increased by the fatigue coefficient k (Equation 9) whenever  $\Delta f_{sd, fad}$  is smaller than  $\Delta\sigma$ . It is mentioned that all steel areas met the normative criteria of ABNT NBR 6118:2014; therefore, it was not necessary to use the k coefficient.

$$k = \frac{\Delta\sigma_s}{\Delta f_{sd, fad}} \quad (9)$$

### 3. Materials and Methods

Three theoretical models of reinforced concrete bridges with different structural systems were used, and all of them have the following nomenclature \_\_B\_\_T RC\_\_, where B represents the number of beams, T de number of cross grinder per bridge, and RC means that the beams and the bridges are made of reinforced concrete. Two, three, and five beam bridges with different spans are used per each bridge deck.

All the nine studied bridges are simply supported, and their designs follow the specifications from the "Manual de Projeto de Obras-de-Arte Especiais", which is a guide written and established by the National Department of Transport Infrastructure (DNIT) of Brazil (DNER, 1996). Moreover, using the information about the characteristics of the Brazilian bridges stock contained in the DNIT (2018) database, it was made the design of these bridge models. Figure 5 shows the cross-sections of the bridges with two, three, and five beams.

All the theoretical bridge models are symmetric, and it was chosen to avoid unnecessary calculus and analysis. In other words, for bridges with two beams, the entire analysis performed for beam 1, B1, are considered the same for beam 2, B2. In the case of the bridges with three beams, the analysis of beam 1, B1, are the same as beam 3, B3, and it is necessary to carry out the analysis about beam 2, B2. In the case of the bridges with five beams, the calculations for beam 1, B1, are the same as beam 5, B5; for beam 2, B2, are the same as for beam 4, B4, and it is carried out the analysis for beam 3, B3.

Furthermore, in the design of the bridges, two traffic lanes were assumed, and each strip has of 3.60 m of width (7.20 m in total), plus two shoulders in each side with 2.40 m each, following the recommendations from the Brazilian Gaudiness "Manual de Projeto Geométrico de Travessias Urbanas" (DNIT, 2010).

The beams of the bridges presented symmetric cross-section in "T" (Figure 2), and they have the

dimensions, as shown in Table 1, according to ABNT NBR 6118:2014 (ABNT, 2014). The concrete compressive strength used has an  $f_{ck}$  of 35 MPa, and the reinforcement steel had  $f_{yk}$  of 500 MPa of yield stress, and the diameters of the bars  $\phi$  are equal to 25 millimeters.

Table 1 –Geometry adopted of the RC beam cross section for the examples

Bridge	2B 1T RC 10	2B 1T RC 15	2B 1T RC 20	3B 0T RC 10	3B 0T RC 15	3B 0T RC 20	5B 0T RC 10	5B 0T RC 15	5B 0T RC 20
$b_w$ (cm)	35	35	35	35	35	35	35	35	35
w (cm)	235	335	435	235	335	350	200	200	200
$d_f$ (cm)	30	30	30	30	30	30	30	30	30
D (cm)	100	150	200	100	150	200	100	150	200

The cross-sections of internal and external beams present the same dimensions. Moreover, since in this work the dynamic analysis of vehicle loads on the bridge is not done directly, but through the use of coefficients from the Brazilian code that simulate this dynamic effect, only the effects caused on the beams alone are studied. Therefore, it is not considered, for example, the types and effects of the bridge bearings. Tables 3, 4 and 5 show the cross-sections ( $A_c$ ), in  $\text{cm}^2$ , moments of inertia in State II ( $I_{II}$ ), in  $\text{cm}^4$ , and reinforcement areas ( $A_s$ ), in  $\text{cm}^2$ , of all bridge model beams.

Table 2 – Characteristic values of 2-beam bridges

Bridge	2B 1T RC 10	2B 1T RC 15	2B 1T RC 20
	B1/B2	B1/B2	B1/B2
$A_c$	9500	14250	19000
$I_{II}$	4578445	15239180	35738242
$A_s$	106.9	137.0	166.7

Table 3 – Characteristic values of 3-beam bridges

Bridge	3B 0T RC 10		3B 0T RC 15		3B 0T RC 20	
	B1/B3	B2	B1/B3	B2	B1/B3	B2
$A_c$	9500	9500	14250	14250	16450	16450
$I_{II}$	3655139	2384790	12008677	8114298	27545509	18731747
$A_s$	82.6	49.6	104.3	67.1	127.8	83.3

Table 4 – Characteristic values of 5-beam bridges

Bridge	5B 0T RC 10			5B 0T RC 15			5B 0T RC 20		
	B1/B5	B2	B3/B4	B1/B5	B2	B3/B4	B1/B5	B2	B3/B4
$A_c$	8450	8450	8450	10200	10200	10200	11950	11950	11950
$I_{II}$	2349799	2019698	2195810	7414837	7080892	6154192	17181223	15234170	14555375
$A_s$	50.3	42.0	46.4	64.7	55.5	52.4	80.6	70.4	66.9

Since the fatigue life is determined using the cumulated damage methodology, the bending moments due to the flexure in the reinforced concrete beams need to be calculated, and they are analyzed in the middle of the span. Because the most critical loads on bridge's beams in the fatigue analysis are the live ones, the influence lines technique is used to obtain the support reactions and internal stresses in bridge's beams with two and multiple beams. In the case of multiple-beam bridges, it is also used the Fauchart Process, which can be found in various publications, such as Stucchi (2016), Trentini, Martins (2015), Moura et al. (2016), Basso, Carvalho, Faria, 2017 e Mascarenhas, Carvalho, 2019.

The software Ftool (Two-dimensional Frame Analysis Tool), which makes 2D structural analysis and uses the Direct Rigidity Method for the analysis, was used (Ftool, 2018). Several authors have used Ftool to carry out their structural analysis of live loads in beams of bridges, such as Mascarenhas, Carvalho, 2019; Rota Oeste S.A (2016), Baroni, 2010, Santos, Perlingeiro, Alves (2017), Turmina (2016), Medeiros (2018), Drun, Souza (2018) e Mascarenhas, Christoforo e Carvalho (2020).

### 3.1 Determination of the normative live load model, TB 450

The Brazilian live load model TB 450, from ABNT NBR 7188:2013 (ABNT, 2013), has six wheels and occupies an area of  $18.0 \text{ m}^2$ , as shown in Figure 4, where  $p$  is the portion of the uniformly distributed load, and it is  $5 \text{ kN/m}^2$ , and  $P$  are the concentrated loads on the wheel axles of the live load model, and it is  $75 \text{ kN}$ .

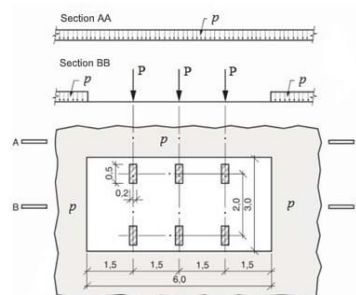


Figure 4 – Live load model according to ABNT NBR 7188:2013

The live load model TB 450 must be placed along the entire cross-section of the bridge where there is a road lane, providing the wheels are in the most unfavorable position. Figure 5 shows the most unfavorable positions for all bridge models.



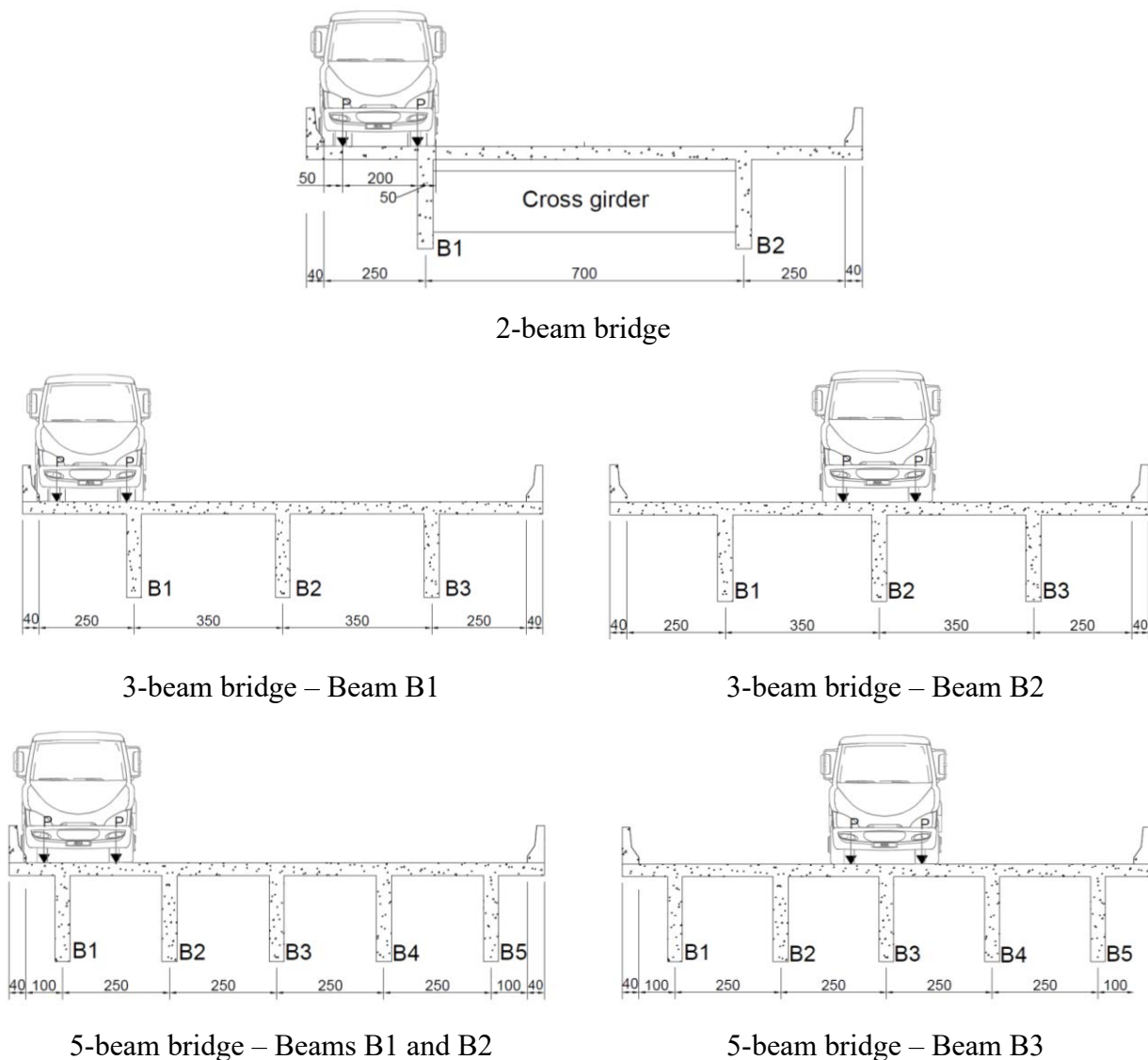


Figure 5 – TB 450 on the cross-section for the maximum stress situation – dimensions in cm

### 3.2 Loads for real freight vehicles

When the fatigue phenomenon is studied, it is necessary to know the position in which the freight vehicles travel on the roads. Due to the heterogeneity of the vehicles, their size variety, and the positions that they commute over the service life of the bridge structures, different internal forces can be caused in the beams depending on the vehicles are. Several kinds of research were carried out to establish the most common position of the vehicles on the road. The Eurocode 1 (2002) advocate that half of the actual vehicles (vertical loads) that travel on the highways are centered on the traffic lane, and the others are distributed symmetrically along the lane.

Hence, in this work, it was considered that 100% of the freight vehicles here analyzed commute in the center of the traffic lane because this adopted position was representative, and other authors assumed it, Albuquerque and Pfeil (2012), Santos and Pfeil (2014) and Mascarenhas and Carvalho (2019). In addition to this, the following considerations about the freight model of real vehicles were assumed:

- I. The procedure for determining both maximum and minimum bending moments from the real vehicles was the same used for the TB 450; however, the real freight vehicles were positioned as shown in Figure 6 (a) (b) (c) for 2-beam, 3-beam and 5-beam bridges, respectively;

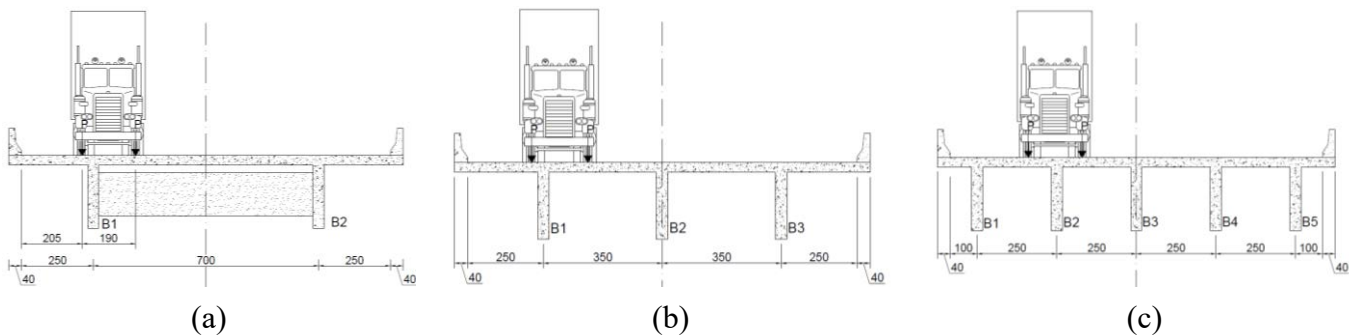


Figure 6 – Transverse position adopted for freight vehicles - dimensions in cm

- II. Crosswise the vehicles have the same dimensions, with 1.90 m from axle to axle (Figure 6). Longitudinally, the dimensions and load values adopted are those shown in Figure 12, following the recommendations from the Brazilian National Transit Council (CONATRAN), which is applied by DNIT (2012);

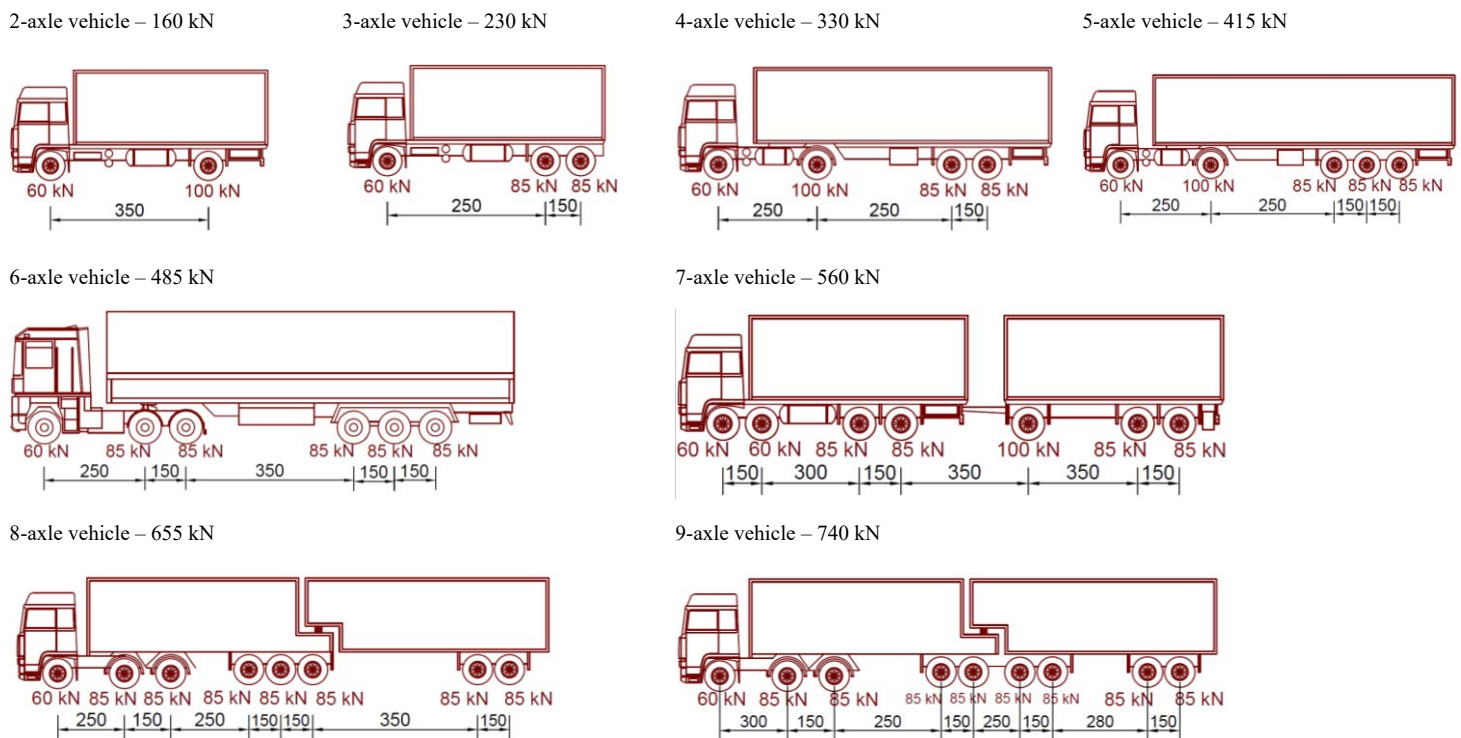


Figure 7 – Representation of 2 to 6 axle freight vehicles

- III. 100% of the real freight vehicles are placed in the centerline of the traffic lane, and it was taken into consideration only one freight vehicle commuting on the bridge, as assumed by Mascarenhas and Carvalho (2019).

#### 4. Results and Discussion

The stress variations had an essential role in fatigue life estimation; then, the following analyzes were performed by comparing the stress variation of the TB 450 and with the ones from the real vehicles of 2 to 9 axles for all bridge models. The results were presented according to the type of bridge. The steel reinforcement areas of all beams were verified regarding fatigue using Equation 8, and all of them satisfy what is stated by the Brazilian standard.

Orange horizontal lines represented the values found for the TB 450, and the real vehicle stress variations were presented using blue lines. Figure 8 (a) (b) and (c) show the values of stress variations in the longitudinal reinforcement for 2-beam bridges of 10, 15 and 20 m, respectively.

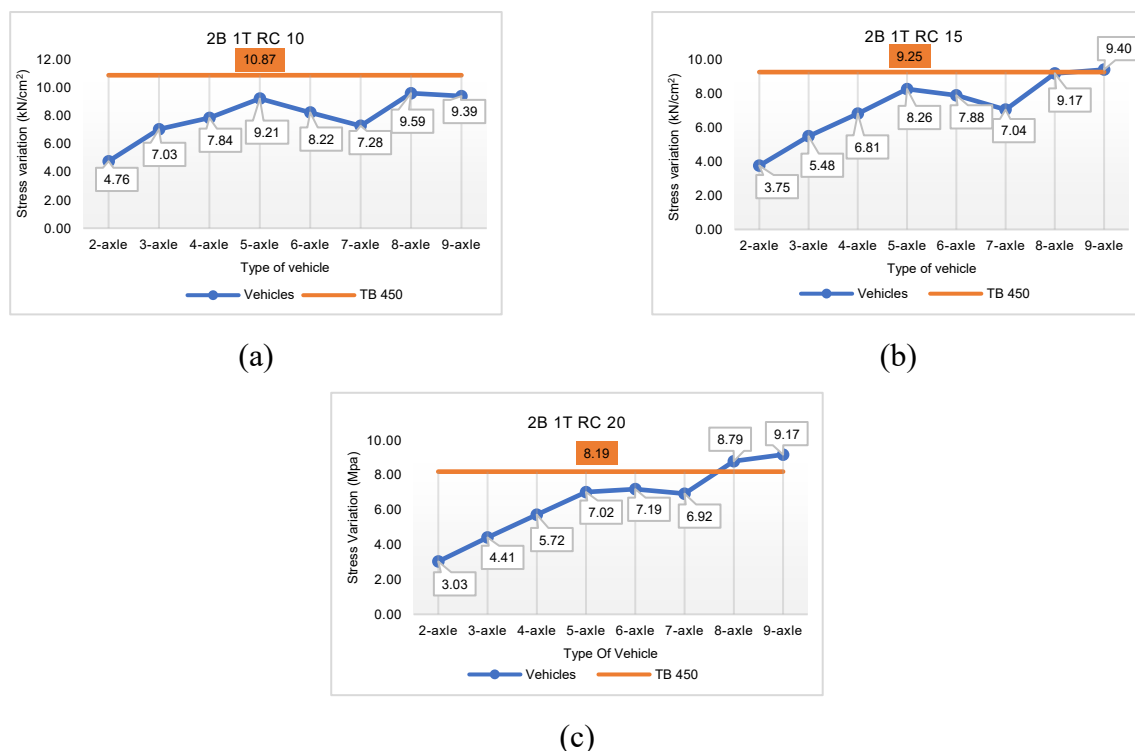


Figure 8 – Stress variations found for bridges with two beams

According to the results, in the three models of bridges, vehicles with 5, 6, 8 and 9 axles were the most critical ones, mainly the 9-axle vehicle. Even though all the stress variations found for the freight vehicles for the bridge 2B 1T RC 10 were not higher than the one from the TB 450, vehicles with 5, 8 and 9 axles were close to it.

In the case of the bridge 2B 2T RC 15, the vehicles with 9 axles presented stress variation over than the one calculated using the TB 450; it was 1.60% higher; therefore, TB 450 was not verified for those that vehicle. Moreover, the 5 and 8 axle vehicles had stress variation close to the one from the TB 450.

For the 2B 3T RC 20 bridge, 8 and 9 axles vehicles presented huger stress variation than the TB 450, and they were, respectively, 6.83% and 10.69% bigger than TB 450, so for those vehicles, TB 450 can be considered not verified. In that bridge model, the vehicles with 5, 6 and 7 axles also had stress variations close to the limit.

After that, the bridge models with three beams are analyzed. The stress variation found for B1 and B2 of 3B 0T RC 10 bridge is shown in Figure 9 (a) and (b).

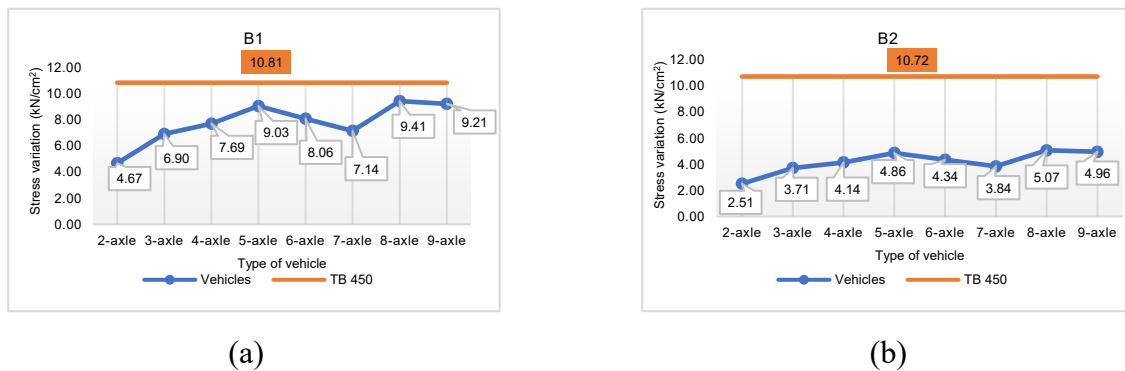


Figure 9 – Stress variations found for bridges with three beams – 3B 0T RC 10

Analyzing the results from Figure 9, it was possible to conclude that for both beams, B1 and B2, the vehicles stress variations were smaller than those found using the TB 450, then TB 450 can be considered verified for them. Besides, beam B1 presented the highest stress variation when it was compared to beam B2, which has average stress variation of the real vehicles around 61% less than the TB 450. Although the stress variations were within the limit in both beams, vehicles with 5, 8 and 9 axles were those that have the highest stress variation.

Figure 10 (a) and (b) describes the results found for the stress variations for bridges with three beams 3B 0T RC 15, for beams B1 and B2, respectively.

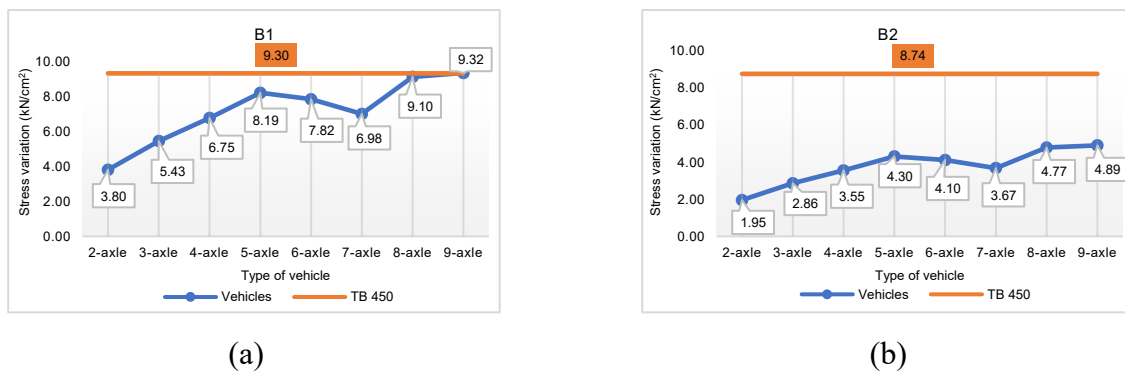


Figure 10 – Stress variations found for bridges with three beams – 3B 0T RC 15

According to Figure 10 (a), it can be seen that B1 has the highest stress variation, and vehicle with 9 axles exceeded in 0.21% the stress variation of TB 450. Also, in both beams, 5, 8 and 9-axle vehicles are the most prejudicial ones.

Figure 11 (a) and (b) show the results found for stress variations for the bridge 3B 0T RC 20, for beams B1 and B2, respectively.

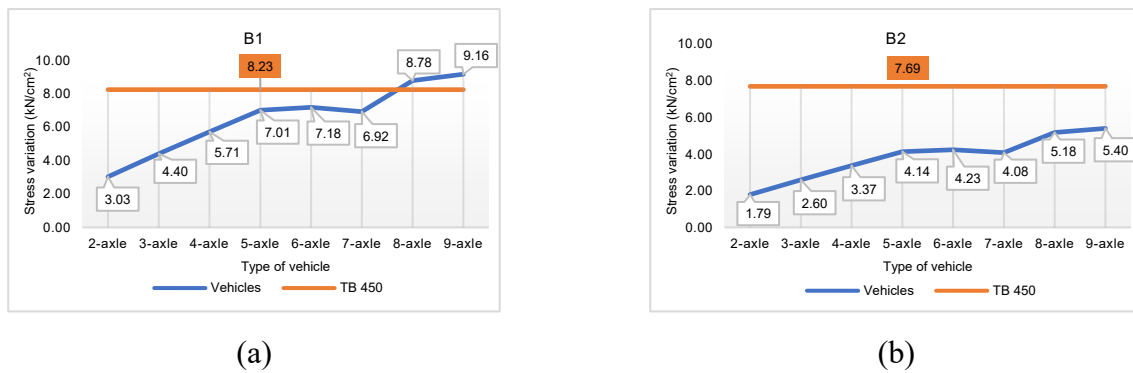


Figure 11 – Stress variations found for bridges with three beams – 3B 0T RC 20

Analyzing the results obtained above, it was noted that in B1, 8 and 9-axle vehicles were over the limit of stress variation of TB 450, 6.26% and 10.15% higher; thus, TB 450 was considered not verified for those. Secondly, B2 presented all the stress variations within the TB 450 limit. Likewise, in the previous bridges, real vehicles with 5, 6, 8 and 9 axles had the highest stress variation in both beams.

Finally, the stress variation calculated for bridges with five beams were analyzed. First, the values for stress variations for the bridge 5B 0T RC 10 were presented in Figure 12 (a), (b) and (c), respectively for beams B1, B2 and B3.

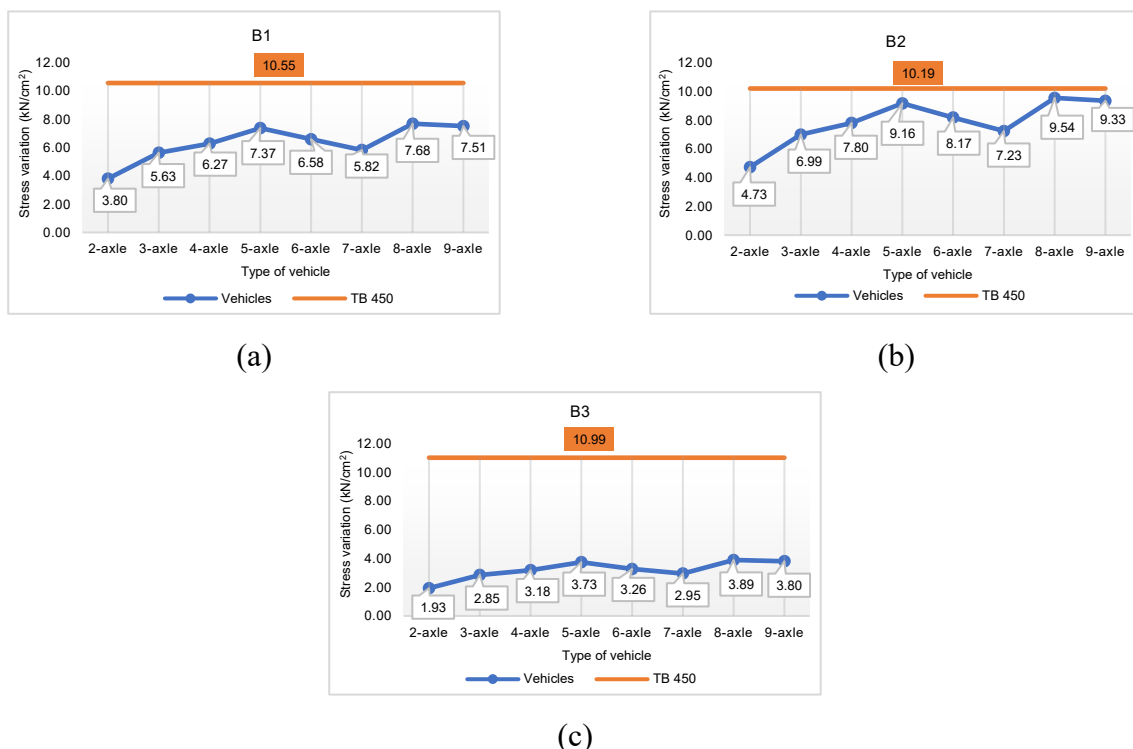


Figure 12 – Stress variations found for bridges with five beams, 10 m span – 5B 0T RC 10

Based on the results from Figure 12, all three beams had the vehicles' stress variations in the reinforcement within the limit stated by their respective TB 450. Also, if we categorize the three beams in ascending order of stress variation, from the lower to the higher, the order is: B3, followed by B1, and then by B2. Although the stress variations due to the real vehicles found in B2 were smaller than the one from TB 450, three of

them were significantly closer to the limit, which leads to understanding that overload trucks can easily present stress variations huger than the TB 450. Once again, in all beams, the vehicles with 5, 8 and 9 axles had the most expressive stress variations.

The results obtained for the bridge 5B 0T RC 15 were presented below for beams B1, B2 and B3, respectively, through Figure 13 (a), (b) and (c).

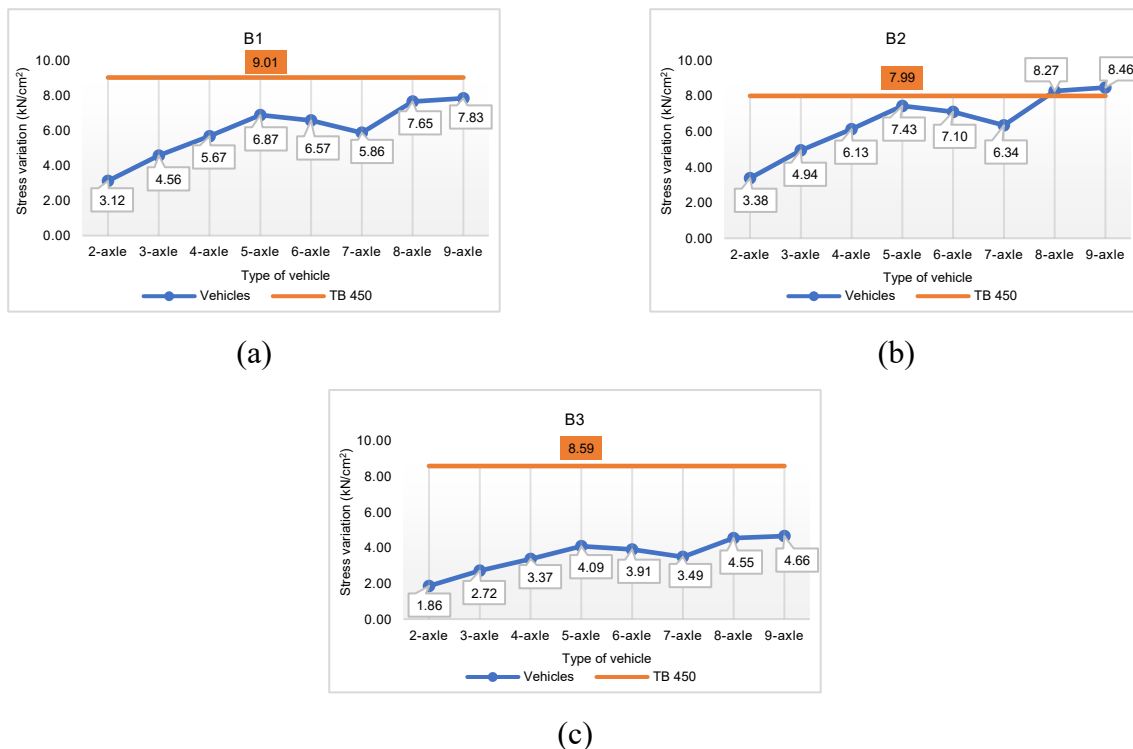
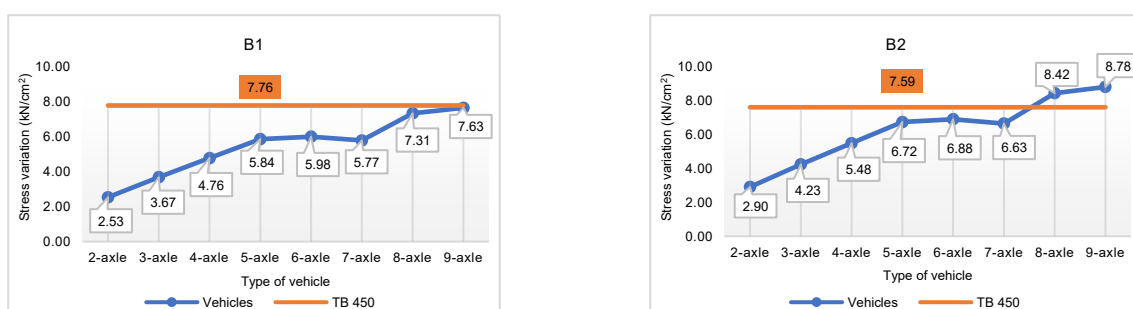


Figure 13 – Stress variations found for bridges with five beams, 15 m span – 5B 0T RC 15

The results found for 5B 0T RC 15 were similar to those obtained to 5B 0T RC 10 in two points. Firstly, beam B3 had the lower stress variation being around 60% less than the TB 450, and beam B2 had the highest ones. Secondly, vehicles with 5, 8, and 9 axles were those with superior stresses compared to the others. B2 presented two vehicles whose stress variation were over the TB 450 limit: 8-axle, which was 3.39% bigger, and 9-axle, which was 5.56% higher than the stress variation from TB 450. Then it was considered not verified for these two vehicles. Also, regarding B2, even though the stress variations of 5 and 6-axle vehicles were not bigger than the TB 450, they were very close to it.

Finally, the results obtained for the bridge model 5B 0T RC 20, for beams B1, B2 and B3, respectively, are presented in Figure 14 (a), (b) and (c).





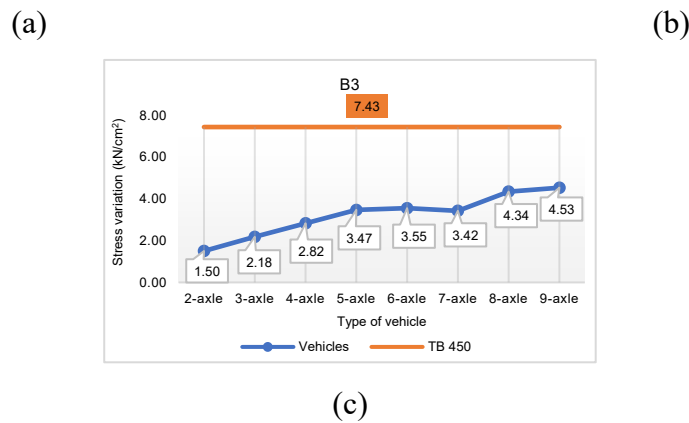


Figure 14 – Stress variations found for bridges with five beams, 20 m span – 5B 0T RC 20

According to the results, it was possible to note that in B1, even though the reinforcement stress variations of the actual freight vehicles did not exceed the limit of TB 450, in 8 and 9-axle vehicles, the calculated values were closer to the respective limit.

B2 had vehicles whose stress variation were higher than the limit. The freight vehicles with 8 and 9 axles had stress variations over the calculated limit, being 9.86% and 13.55% 1.19% higher, respectively. Then, for those vehicles, TB 450 can be considered not verified. Moreover, the vehicles with 5, 6 and 7 axles had stress variations up close to the limit. Finally, in all the beams, the freight vehicles with 5, 6, 8 and 9 axles were those with higher stress variations.

#### 4.1 Results and findings overview

This section summarizes the findings and contributions made. First, bridges and viaducts are relevant and “their absence or restricted operation by load, width or height limitations considerably reduces the level of service on the respective road segment” (Echaveguren, Dechent, 2019).

Second, the results found in this paper tie well with previous studies wherein both, this and the previous ones, have demonstrated that the longitudinal steel reinforcement of reinforced concrete beams is very susceptible to the deleterious effects of the phenomenon of fatigue. Consequently, the steel reinforcement deserves special care and attention from engineers, designers, and research, whether in the stages of design, structural recovery, so that more research and studies at the national level can be developed.

Third, according to the results, the freight vehicles with 5, 6, 8 and 9 axles were those that presented the higher stress variations in all studied beams of all bridge models, therefore, being those that tend to cause more deleterious effects compared with the others analyzed. These results lead to similar conclusions that have been found in previous studies, such as Pircher *et al.* (2011) and Rossigali *et al.* (2015). Moreover, if this analysis was performed, taking into consideration the data from the three toll collection points, roads with a huge volume of those vehicles deserve attention. In toll collection point 01, 5-axle is 12% of total, 6-axle is 23%, 7, 8 and 9-axle vehicles represent 14% (49% in total). In toll collection point 02, 5-axle is 13% of total, 6-axle is 18%, 7, 8 and 9-axle vehicles are 14% (41% in total).

In addition to this, although the vehicles with 2 and 3 axles did not have the highest stress variation (compared to the most critical ones), in the two collection points, they have a substantial percentual number.

In collection point 01, 2-axle and 3-axle vehicles represented 50%, in toll collection point 02, they were 42%.

As stated before, it is not only the increase in the number of vehicles that deserves attention but also the increase in their weight is also a cause for concern. The dimensions and total weight of the vehicles of 2 to 9 axles used in this study follow the legal limits established by CONATRAN. However, freight vehicles with loads that exceed legal limits are a reality in Brazil (CNT, 2019, Fontenele, Zanuncio, Silva Júnior, 2011, Réus, Silva Júnior, Fontenele, 2014).

The previous results showed that, in some beams, although the reinforcement stress variations calculated to certain freight vehicles were smaller than their respective TB 450, they were closer to them. Then, overloaded freight vehicles are a risk, and they can cause huger stress variations than the expected ones.

Furthermore, analyzing the bridge models with three beams, the results demonstrated that in all models, beam B1 (and for consequence beam B3 because of the symmetry of the structure) was the most requested one in terms of bending moment and, consequently, of flexural stress variations in the longitudinal reinforcement. It occurred due to the position adopted to the freight vehicles that are above B1, as shown in Figure 6 (b).

Moreover, in the case of bridge models with five beams, the found results show that the beam B2 (and consequently, beam B4 due to the symmetry of the structure) presents the higher stress variations in the longitudinal stress reinforcement. It happened due to the position adopted to the freight vehicles that were above beam B2, as shown in figure 6 (c).

Based on that, using the reinforcement stress variations found in the most critical beams, Figure 15 (a) (b) (c) shows the relationship between the spans and the number of axles for bridges with two, three and five beams, respectively.

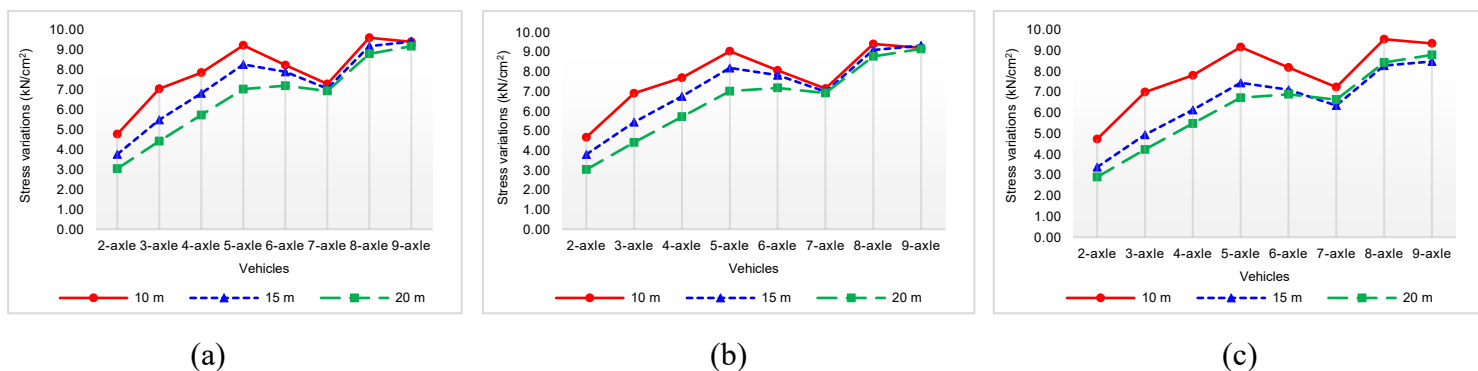


Figure 15 – Relationship between the spans and the number of axles for bridges

As shown by works found in the related literature, the results presented in Figure 15 explain that bridges with small spans are the ones that suffer the most from the deleterious effects of fatigue, since the values of reinforcement stress variations found for 10 m span bridges are the highest among the three models of bridges studied. Then, the biggest the stress variations, the biggest the fatigue damage.

It is essential to mention that the beams cross-section influence in fatigue resistance, so changing the cross-section of the beams may make them have bigger or smaller fatigue damage, which is directly linked with the stress variations. Secondly, the more beams the bridge has, the more efforts received by the deck are distributed to these beams; thus, the efforts on each beam tend to decrease.

Finally, it should be emphasized that this work considers only the passage of a single freight vehicle at a time in the analyzed bridge models. With this, the numerous passenger vehicles that travel are not taken into account, nor as certain traffic situations such as: more than one vehicle of the same type commuting together on the bridge, or more than one vehicle of different types traveling on the bridge, or when there is traffic on only one of the lanes, and the vehicles are stopped on the other lane of traffic on the bridge.

Those considerations are made to show that there are traffic situations that are much more complex, and they tend to generate greater demands on the structural elements of the bridges. Consequently, more significant variations in stresses will arise in the longitudinal reinforcement, which will increase the deleterious effects and damage due to fatigue.

Also, the Brazilian bridge standard has never presented guidelines or methodologies for evaluating, studying, and dimensioning existing or future bridges when data on actual freight vehicles are available. Therefore, considering that there are traffic situations that can generate higher tensions, based on the considerations assumed here and the results presented, it is evident the need for the Brazilian bridge standard to adopt a specific train and specific coefficients for fatigue, as well as study and design methodologies when real vehicle data are available.

All those results, associated with other factors, such as the high age of Brazilian bridges and viaducts, the lack of periodic inspection and maintenance of these structures, the lack of public policies for structural conservation and recovery, as well as the lack of fatigue coefficients and live load models to fatigue are serious factors. They deserve attention because they can lead to structural problems and the rupture of these structures of paramount importance for the Brazilian infrastructure and economy.

## **5. Conclusions**

Bridges and viaducts are elements of great importance in the infrastructure network of cities, states, and countries, especially in Brazil, which has road transport as the predominant one even more concerning road freight transportation, whose total is significant. Because of that, the increase in the number of heavy vehicles on highways and the high age of bridges and viaducts in Brazil, this work had as main objective to verify if the current Brazilian normative live load train, TB 450 was capable of representing the real freight vehicles of 2 to 9 axles concerning the fatigue process in the longitudinal reinforcement of reinforced concrete bridge beams.

The main results and conclusions found in the analyzes carried out in this work are presented below:

- a) The longitudinal steel reinforcement is significantly affected by the deleterious effects of fatigue.
- b) The freight vehicles with 5, 6, 8 and 9 axles are those that presented the higher stress variations in the reinforcement in the bridge models.
- c) In the bridge models with two beams, beam B1 was the most critical one, and TB 450 was considered as not verified to bridge model 2B 2T RC 15 regarding the vehicle with 9 axles; and bridge model 2B 3T RC 20 regarding the vehicles with 8 and 9 axles.
- d) In the bridge models with three beams, beam B1 was the most critical one, and TB 450 was considered as not verified to bridge model 3B 0T RC 15 regarding the vehicle with 9 axles; and bridge model 3B 0T RC 20 regarding the vehicles with 8 and 9 axles.

- e) In the bridge models five beams, beam B2 was the most critical one, and TB 450 was considered as not verified to bridge model 5B 0T RC 15 regarding the vehicles with 8 and 9 axles; and bridge model 5B 0T RC 20 regarding the vehicles with 8 and 9 axles.
- f) Although in some bridge models, the reinforcement stress variations were not hugger than their correspondent TB 450, they were very close to the limit. Taking into consideration that many vehicles travel on Brazilian highways with excess weight, this requires attention, as it can increase the active stresses on the bridge structures.
- g) As the American, European and Chinese codes have both fatigue specific coefficients and load train models, it is recommended that the Brazilian code establishes its fatigue load train and coefficients, which need to be in line with the reality of Brazilian traffic and bridges. Therefore, it is recommended the development and adoption of specific methodologies, procedures, and coefficients regarding the phenomenon of fatigue to the study, design, and structural recovery of either elderly, current and forthcoming bridges and viaducts in Brazil. The adoption of such factors will allow that projects of bridges can be made more precisely, safely, and economically, and the Brazilian Bridges Code can be as robust and comparable to the best international bridge codes.

Finally, it is worth discussing these significant facts revealed by the results in terms of the Brazilian highway roads and freight vehicles. Without a doubt, the fatigue phenomenon is a current and relevant issue in the verification and design of road bridges and viaducts, and it deserves a careful investigation (experimental and/or numeric). Hence, it is highly necessary the adoption of a specific load train and specific coefficients to the fatigue phenomenon so that the analyzes of pre-existing road bridges and the design of new ones can be made most properly. So that, then, they present satisfactory structural performance over their service lives, and they are in constant consonance and adequacy with their current traffic conditions.

## 6. Acknowledgement

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# **Self-regulation and Self-identity Changes among Iranian EFL Learners**

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## **Abstract**

*The present study aims to investigate the probable association between self-regulated strategies and self-identity changes among Iranian EFL learners. To achieve this purpose, 80 EFL students were selected according to convenience sampling from different language institutes in Mashhad. They were requested to complete the 'Motivated Strategies for Learning Questionnaires' (MSLQ) and 'Self-identity Changes' questionnaires. The findings yielded via correlation supported the theoretical expectation of a linkage between self-regulation and self-identity changes. The result revealed that there is a significant relationship between teachers' self-regulation high scores and self-confidence changes. Subsequent data from step-wise regression indicated that among sub-components of self-regulation, regulation, efficacy, and intrinsic value are the best predictors of learners' self-confidence changes. The conclusions and implications of the research are further discussed with reference to earlier finding.*

**Keywords:** Self-regulation; self-identity changes; EFL learners; Efficacy; Intrinsic value

## **1. Introduction**

For enriching the quality of teaching as well as learning and also tackling with many unpredictable problems encountering in educational context we need a toolbox of strategies along with body of awareness (Kumaravadivelu, 2006). As Larsen-Freeman (1997) proposed an interesting metaphor "chaos/complexity theory" for second language acquisition in which SLA is viewed as a dynamic, complex, and nonlinear process that even the minor things should be taken into consideration (Brown, 2007). In accordance with learning a second language, a second identity is achieved; so confronting new culture may result in changes

in the learner's perceptions of the world, self-identity, belief system, feeling, emotions, function, and communicating (Brown, 2007).

"Self-regulation (or self-regulated learning) refers to learning that results from students' self-generated thought and behaviors that are systematic oriented toward the attainment of their learning goals" (Schunk & Zimmerman, 2003. p.59). Self-regulated learning respects both personally directed forms learning like discovery learning, as well as social forms of learning such as seeking help from classmates, parents, teachers (Zimmerman & Schunk, 2007, cited in Zimmerman, 2008). According to Bandura, (1993) providing students with self-regulatory abilities lead to their educational achievement as well as lifelong learning (Young, 2005).

Since through learning process we represent who we are and what we are able to do, we can have an experience of identity (Wenger, 1998, p.215 cited in Pavlenko & Norton, 2007). Norton (1997, p.410), defines identity as to reference how a person understands his or her relationship to the world, how that relationship is constructed across time and space, and how the person understands possibilities for the future. Hall, Cheng, and Carlson, (2006), negotiated a usage-based view of language knowledge that viewed human learning via involvement in interaction and activities using cultural means and they found that concerning social and cultural status, individuals differ in their participation (Norton & Toohey, 2011).

The major purpose of the current study is to empirically explore the theorized association between self-regulation and self-identity changes among Iranian EFL learners. The researcher of the present study set out to investigate this association based on logical reasoning that based on sociocultural learning theory, cultural factors play a significant role in developing learners' self-regulation and this self-regulation is improved in a meaningful and collaborative environment (Butler, 2002). Self-regulation consists of three subcomponents: self-observation, self-judgment, and self-reaction (Schunk, 1996). *Self-observation* (italics in original) refers to intentional focus on individual behaviors encompassing determinants and wills, *self-judgment* (italics in original) includes the consistency between individuals present performance level and their goals and *self-reaction* (italics in original) refers to humans evaluation of their performance (Schunk, 1996) which is according to Paris and Winograd, (?) generally, people tend to evaluate their own behavior when they feel these behaviors are compatible with "their preferred or desired identity". So it was hypothesized that such a link exists between these constructs.

## 2. Theoretical Background

### 2.1 Self-Regulation

Self-regulation can be defined as self-generated thought, feeling, and actions for attaining academic goals (Zimmerman, 1998, p.73). Pintrich (1999), proposed a model of self-regulated learning consisting of three main classifications of strategies: (1) cognitive learning strategies, (2) self-regulatory strategies to control cognition, and (3) resource management strategies. Derived from the Weistein-Mayer' study (1986, cited in Pintrich, 1999) cognitive learning strategies can be manifested as rehearsal, elaboration, and organizational strategies; in that these strategies can be employed in a wide range of tasks including simple memory task (e.g. remembering words, lists) or to more difficult and complicated tasks involved comprehension of the information (e.g. understanding a piece of text or a lecture), (Pintrich, 1999).

Rehearsal strategies deal with the recitation of materials to be learned, highlighting text in a passive and unreflective way. These rehearsal strategies can assist learners to devote more attention and choose the significant knowledge from lists of items and keep information active in working memory (Pintrich, 1999). Elaboration strategies concern with summarizing the material to be learned, being conscious of analogies, interpreting the learned knowledge to someone else. Organizing strategies requiring deeper processing concern behaviors like finding the main idea of from text and employing various particular techniques for selecting and organizing the ideas in the materials.

Metacognitive and self-regulatory strategies include three general categories: planning, monitoring, and regulating (Pintrich, 1999). Planning refers to students' learning such as setting goals for studying, skimming a text before reading and performing a task assessment of the required problem. Monitoring of one's thinking and academic behavior is a critical factor of self-regulated learning. Weinstein and Meyers (1986, cited in Pintrich, 1999) imply that all metacognitive strategies have a function of monitoring of comprehension where learners check their understanding against some self-set goal. Determining a goal or some norms are an essential part of self-regulation (Pintrich, 1999). Monitoring activities consist of tracking the attention while reading a text or listening to a lecture, self-testing via applying questions about the text material to control for understanding. Regulation strategies are close to monitoring strategies and when learners set a goal, they monitor their learning based on their determined goals and these monitoring process provide the for regulation processes to provide behaviors consistent with pre-set goals.

Resource management strategies include techniques that learners employ and control their environment such as controlling their time, effort, study environment, teachers, peers by application of help-seeking strategies (Pintrich, 1999). Attributional feedback is influential in self-regulated learning since it enhances both learners' motivation, their sense of efficacy, and achievement (Schunk & Zimmerman, 2003). When learners set a goal, they find a sense of efficacy which encourages them to devote more time and effort to achieve their goals (Schunk, 1996).

Drawing some ideas of mainstream psychology, (Boekaerts, 1997; Boekaerts & Niemirierita, 2000) design a model of self-regulation in which learners confront two priorities in the educational context (Boekaerts & Corno, 2005). The first priority leading to increase resources is obtaining growth goals such as learners understand their knowledge fully or add cognitive or social skills. The second priority is when students sustain emotional well-being within reasonable bounds; this situation occurs when students protect their ego. Boekaerts postulates that learners attempt to modulate these two priorities (Boekaerts & Corno, 2005). Boekaerts proposes two parallel procedures that derived from classroom self-regulation; Top-down regulation and bottom-up regulation (Boekaerts & Corno, 2005). Motivational factors like personal interest, values, and expected satisfaction encourage mastery attempts in top-down self-regulation. Winne (1995) determined some features of self-regulated learners in the form of the cognition, emotion, and action of top-down SR (Boekaerts & Corno, 2005, p.203).

When they begin to study, self-regulated learners set goals for extending knowledge and sustaining motivation. They are aware of what they know, what they believe, and what the differences between these kinds of information imply for approaching tasks. They have a grasp of their motivation, are aware of their affect, and plan how to manage the interplay between these as they engage with the task (Winne, 1995, p.173).



When environmental factors stimulate self-regulation process, the bottom up self-regulation happens. In this type of self-regulation, the role of feedback is significant (Boekaerts & Corno, 2005).

## **2.2 Identity**

Traditionally, identity like other individual factors (e.g. learning styles, motivation, etc...) were respected fixed, unitary and decontextualized; however; recently, following poststructuralist theories of identity, it is viewed as dynamic, context-based, and context-producing specially historical as well as cultural studies (Norton & Toohey, 2011). In a similar vein, Gao, Li, & Li (2002) with respect to social constructivist, claim that identity is regarded as socially constructed and socially situated. In this perspective, while context 'pushes back' on individuals' claims to identity, individuals also try to conceive identities that they wish to claim (Norton & Toohey, 2011).

Drawing Bakhtin's emphasis on the role of position in conversation, a great deal of identity and language learning researchers focus on how the positioning among involved participants is formed by context (Norton & Toohey, 2011). Poststructuralists regard identity as contingent, shifting and context-dependent and that while identities or positions are often given by social structures or ascribed by others, they can also be negotiated by agents who wish to position themselves (Norton & Toohey, 2011). Menard-Warwick views customary educational curriculum and tasks and powerful social discourse, limit learners' options for ideal identities (Norton & Toohey, 2011). She recommended teachers should have an awareness of students' positioning in learning discourse and design facilitating students' attempts to remove disempowering tendencies of the linguistic practices of their new culture. The term investment proposed by Norton (1995) derived from the idea of Bourdieu's cultural capital (Norton, 2010) when she recognized that high levels of motivation does not essentially lead to good learning. Unlike preceding studies on motivation which focused on humans' personality as internalized, ahistorical, and fixed construct, investment gives prominence on learners' changeable identity which shift from across time and space and regenerated in social interaction (Norton, 2010). If learners invest in a second language, they realize that this investment contributes to enriching their cultural capital which as the result aids to reassessment of learners' sense of themselves. (McKinney & Norton, 2007).

A conceptualization of subjectivity as multiple, non-unitary, and dynamic for identity paved the way this fact that people are not fixed in a particular situation and this idea contribute to offer pedagogical practices to have the potency and the capacity of transformation in providing language learners more powerful positions compared with insider or outsider the classroom (Norton & Toohey, 2011).

"We humans are capable, through our imagination, of perceiving a connection with people beyond our immediate social networks. Our orientation toward such imagined communities might have just as much impact on our current identities and learning as direct involvement in communities of our everyday life" (Pavlenko & Norton, 2007, p. 670). In essence, learning English as a second (ESL) or foreign language (EFL) is not considered as a matter of code switching (Lin, 2009). The interpretive principles and paradigms in learners' natal culture may have an effect on many dimensions of learner's second language learning Hinkel, 1999, cited in Lin, 2009). By the aid of learner's home culture, learners can confidently understand pragmatic implication of the target language and develop in target language communicative activities (Lin, 2009).



To the researcher's best knowledge no study has been done to date explore the probable relationship between Iranian EFL learners' self-regulated strategies and their self-identity changes. Furthermore, this study investigates the positive predictor/s of EFL learners' self-identity changes among sub-capabilities of self-regulated strategies. Therefore the current study aims to answering:

1. Is there any significant relationship between EFL learners' motivational and self-regulated strategies and self-identity changes?
2. Among the sub-components of motivational and self-regulated strategies, which of them are the best predictors of learners' self-identity changes?

### 3. Methodology

#### 3.1 Participants

A total of 80 EFL students (N=80) took part in this research. The majority of these participants graduated in different branches of English, 28 had MA or student of MA in English teaching, 18 had BA in English literature, 23 had MA or student of MA in English translation. 11 of these participants were from engineering and applied sciences. 34 students were male and 46 ones were female. All of them were from different language schools in Mashhad, a city in the northeastern in Iran. Their age varied from 23 to 49 years old. Their English background varied from 2 years to 9 years.

#### 3.2 Instrumentation

##### 3.2.1 Motivated strategies for Learning Questionnaire

To measure students' self-regulated strategy use, they were given the (Motivated strategies for learning questionnaire) MSLQ designed by Pintrich and DeGroot, (1999). The test comprised 44 items which is classified into two main categories; the motivated beliefs include three subcategories: self-efficacy (9items), intrinsic value (9items), and test anxiety (4items). The self-regulated learning strategies encompass two subcategories: cognitive strategy use (13 items) and self-regulation (9items). In the current study the Cronbach's alpha for this scale is .75.

##### 3.2.2 Self-Identity Changes

For evaluating learner's self-identity changes, self-identity changes questionnaires designing by Gao et al., (2007) was applied. This form includes 24 items which has 6 types. Each type has 4 items. Gao, et al. (2007), provide a definition for each category as follows:

- *Self-confidence change*: Change in the perception of one's own competence.
- *Additive change*: The coexistence of two sets of languages, behavioral patterns, and values, each specified for particular contexts.
- *Subtractive change*: the native language and native cultural identity are replaced by the target language and target cultural identity.
- *Productive change*: the command of the target language and that of the native language positively reinforce each other.
- *Split change*: The struggle between the languages and cultures gives rise to identity conflict.

- *Zero change*: Absence of self-identity change.

In order to suit the Iranian EFL context, the word Chines changed to Persian. The full score of each type of self-identity change was 20, with 12 as the critical value between changed and unchanged states (Gao et al., 2007). In the current study the Cronbach's  $\alpha$  for this instrument is .70.

### 3.3 Procedure

The process of data collection was carried out for three weeks. The participants were given the MSLQ and Self-identity Changes Questionnaire to fill in for 30 minutes. In order to give participants confidentiality, they were asked not to write their names so the two questionnaires were coded numerically. For analyzing the data, the researcher applied SPSS 20 program. To explore whether there was any correlation between learners' self-regulated learning strategies and self-identity changes, Pearson-product moment correlation was employed. At the end by applying step-wise regression the researcher found out which subcomponent of motivation and self-regulated strategies are best predictors of self-confidence changes.

## 4. Results

In order to determine whether a relationship exists between participants' self-regulated learning strategies and self-identity changes, a bivariate correlation was performed, the result of which revealed a significant positive correlation between the self-regulatory strategies and self-confidence changes.

Table 1. Correlations

		Self-Regulation Total	Self-Confidence Changes
Self-regulation total	Pearson Correlation	1	.565**
	Sig. (2-tailed)		.000
	N	80	80
Self-confidence changes	Pearson Correlation	.565**	1
	Sig. (2-tailed)	.000	
	N	80	80

\*\*. Correlation is significant at the 0.01 level (2-tailed).

To further analysis the data, the researcher conducted the regression analysis with a Stepwise method. The results revealed that which subscales of MSLQ are best predictors of learners' self-confidence changes. The best predictor was regulation that can predict learners' self-confidence changes (Adjusted  $R^2=.23$ ,  $p<0.5$ ), indicating that students who scored high in regulatory strategies benefit more confidence in their foreign language learning compared with students with low scores in the regulatory strategies. The second positive predictor is efficacy which account about 0.21( $p<0.5$ ) of the variance in self-confidence changes. Finally, the third best predictor is intrinsic value, accounting about 0.16( $p<0.5$ ) of the variance in self-confidence changes.

Table 2. Stepwise regression analysis predicting self-confidence changes

	<b>R</b>	<b>R Square</b>	<b>Adjusted R Square</b>	<b>Std. Error of the Estimate</b>	<b>Beta</b>
<b>Regulation</b>	.494	.244	.234	1066328	.494
<b>Efficacy</b>	.475	.225	.215	1068365	.475
<b>Intrinsic Value</b>	.418	.175	.166	1073769	.418

## 5. Discussion

Consistent with the hypothesized relationship between students' self-regulation and their self-identity changes, the results of researcher's findings demonstrated a significant correlation between students' motivational and self-regulated strategies and their self-confidence changes. In other words, the learners who apply more motivational and self-regulated strategies in EFL learning situations are more confident than learners whose self-regulatory strategies are low. This is in line with theoretical previous study; "Self-regulated learners approach educational tasks with confidence, diligence, and resourcefulness. Perhaps more importantly, self-regulated learners are aware when they know a fact or possess a skill and when they do not. Unlike their passive classmates self-regulated students proactively seek out information when needed and take the necessary steps to master it" (Zimmerman, 1990, p.4). Both self-regulation and identity share ideas with goal orientation theory; self-regulation and goal orientation (Pintrich, 2004), identity and goal orientation (Kaplan & Flum, 2010). Goal orientations can be regarded as rather comprehensive social-cognitive mental frames that lead people in interpreting situations, processing information, confronting tasks, and coping with challenges (Kaplan & Flum, 2010).

Based on of Vygotsky's study of individual's regulation process, Postholm (2011) refers to the social community as the departure point of individuals' regulations, a process that gradually will be internalized by the learners, thus becoming one of the individuals' skills. This signifies the important role of social context on self-instruction (Postholm, 2011). From another perspective, Bourdieu's concept of cultural capital as "knowledge, skills and other cultural acquisitions, as exemplified by educational or technical qualifications" (1991, p.14, cited in Menard-Warwick, 2005) reflects cultural equipment as important factor in forming EFL learners' interaction (Menard-Warwick, 2005). Social constructivist theory of self-regulation is based on cognitive development (Schunk & Zimmerman, 2003). Developmental theories shed light on the concept that human beings have an intrinsic motivation to learn, discover, understand, and control their environment (Schunk & Zimmerman, 2003). People put meaning on their conceptions of their prior experiences (Schunk & Zimmerman, 2003). Interpreted in the educational context, it seems sensible that learners devoting more motivation in challenging task and can control and monitor their required task are make sense of their learning process better than their classmates who lack motivation and manipulation of their task. Within psychology-based research, "the idea that students' self-beliefs play a central role in their academic success is so widely accepted that self-constructs are a regular staple in studies of academic

motivation” (Pajares & Schunk, 2005, p.95, cited in Mercer, 2011). In a similar vein, Marcia (1980) refers to identity as internal self-constructed, dynamic organization of people's capabilities, beliefs, and people history. The better developed this construct the more cognizant people seem to be of their own uniqueness and similarities to other people and of their own strength and breakdowns in perceiving the world (Marcia, 1980). The less developed this construct, the more confused the people about their qualities from others and depend more on external sources for assessing themselves (Marcia, 1980).

The researcher's second question aimed at exploring statistically which components of EFL learners' self-regulation are the best predictors of self-confidence changes. The results indicated that regulation, efficacy, and intrinsic values are the positive predictors of self-confidence changes respectively. It is in line with pervious theoretical study. Capara et al. (2008) states some prominent features of self-efficacious students: when confronting with school tasks, self-efficacious students are confident in managing task difficulty, dealing with difficulties as challenges, devote more effort to accomplish their academic task which contribute to their learning improvement. In another study, Shunck (1990) pointed to self-evaluation as a sub process of self-regulation and mentioned that when learners set a goal and judge about their goal process, they find enrichment in their efficacy as a consequence goal achievement encourage students to set new challenging goals. This self-efficacy is under the influence of learners' abilities, prior experience, beliefs about learning, instruction, and the social context (Schunk, 1990).

Regarding intrinsic value as the third positive predictor, achievement goal orientation and identity formation styles tend to share some concerns within the scope of identity and educational motivation as well as their probable associations (Kaplan & Flum, 2010; Both components focus on the importance of mental frames that guide adolescents in making sense of their experiences, world as well as in performance (Kaplan & Flum, 2010). These concepts depend on self-development and self-enhancement motives that encourage people to manage and adapt to the physical and social environment (Erikson, 1968; White, 1959, cited in Kaplan & Flum, 2010).

## **6. Conclusion**

Regarding Kramsch's words (2001) “learning another language is not like learning math or word processing. Especially in adolescence, it is likely to involve not only the linguistic and cognitive capacities of the learner as an individual, but her social, historical, emotional, cultural, moral sense of self as a subject” (p.12, cited in Lin,2009), Lin (2009) suggests L2 curriculum should respect students' mother cultural identities and should also encourage learners to be aware of their own cultural values and beliefs since through these appreciation and respect toward their home culture, the learners can develop their second or foreign language learning achievement more successfully (Pierce,1995, cited in Lin, 2009). Teachers with high level of efficacy are aware of applying the appropriate strategies at the apt situations which improves both teachers and learners' autonomy (Randi, 2004), particularly these days of post method era that according to Kumaravdivelu (2006) "the post method learner is an autonomous learner. Because language learning is largely an autonomous activity, promoting learner's autonomy is vitally important".

The current study has some limitations: first the role of gender, English learning background, learners' degree are not taken into consideration statistically. So it is recommended that a further research including

these factors will be needed. Second, all the participants' mother language was Persian. In the researcher's view point it is interesting to carry out a research and see how other learners of other languages make sense of the culture of the target language and whether the second or foreign language learning influence on the same ways as Iranian learners or not.

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## Appendix

### Appendix 1. Questions applied in the current study

The following scales and items represent the Motivated Strategies for Learning Questionnaire (MSLQ) that was used in this study to measure students' motivational beliefs and self-regulated learning. The numbers next to the items reflect the item's actual position on the questionnaire. Items marked (\*R) were reflected before scale construction. There were 56 items on the questionnaire, but only 44 were used in this study to form the following five scales" (Pintrich & De Groot, 1999, p. 40).

#### Motivational Beliefs

##### A. Self-Efficacy

2. Compared with other students in this class I expect to do well.
7. I'm certain I can understand the ideas taught in this course.
10. I expect to do very well in this class.
11. Compared with others in this class, I think I'm a good student.
13. I am sure I can do an excellent job on the problems and tasks assigned for this class.
15. I think I will receive a good grade in this class.
20. My study skills are excellent compared with others in this class.
22. Compared with other students in this class I think I know a great deal about the subject.
23. I know that I will be able to learn the material for this class.

##### B. Intrinsic Value

1. I prefer class work that is challenging so I can learn new things.
5. It is important for me to learn what is being taught in this class.
6. I like what I am learning in this class.
9. I think I will be able to use what I learn in this class in other classes.
12. I often choose paper topics I will learn something from even if they require more work.
17. Even when I do poorly on a test I try to learn from my mistakes.
18. I think that what I am learning in this class is useful for me to know.
21. I think that what we are learning in this class is interesting.
25. Understanding this subject is important to me.

##### C. Test Anxiety

3. I am so nervous during a test that I cannot remember facts I have learned.
14. I have an uneasy, upset feeling when I take a test.
24. I worry a great deal about tests.
27. When I take a test I think about how poorly I am doing.

#### Self-Regulated Learning Strategies

##### D. Cognitive Strategy Use

30. When I study for a test, I try to put together the information from class and from the book.
31. When I do homework, I try to remember what the teacher said in class so I can answer the questions correctly.
33. It is hard for me to decide what the main ideas are in what I read. (\*R)
35. When I study I put important ideas into my own words.

- 36. I always try to understand what the teacher is saying even if it doesn't make sense.
- 38. When I study for a test I try to remember as many facts as I can.
- 39. When studying, I copy my notes over to help me remember material.
- 42. When I study for a test I practice saying the important facts over and over to myself.
- 44. I use what I have learned from old homework assignments and the textbook to do new assignments.
- 47. When I am studying a topic, I try to make everything fit together.
- 53. When I read material for this class, I say the words over and over to myself to help me remember.
- 54. I outline the chapters in my book to help me study.
- 56. When reading I try to connect the things I am reading about with what I already know.

#### *E. Self-Regulation*

- 32. I ask myself questions to make sure I know the material I have been studying.
- 34. When work is hard I either give up or study only the easy parts. (\*R)
- 40. I work on practice exercises and answer end of chapter questions even when I don't have to.
- 41. Even when study materials are dull and uninteresting, I keep working until I finish.
- 43. Before I begin studying I think about the things I will need to do to learn.
- 45. I often find that I have been reading for class but don't know what it is all about. (\*R)
- 46. I find that when the teacher is talking I think of other things and don't really listen to what is being said. (\*R)
- 52. When I'm reading I stop once in a while and go over what I have read.
- 55. I work hard to get a good grade even when I don't like a class.

#### *Appendix 2. Questions used in this study*

Self-identity changes questionnaire, Gao et al., 2007, as mentioned in 3.2.2, the word Chines changed to Persian

#### *Self-confidence change*

- 1-I feel terrific when I find my command of English is better than that of others.
- 2-English learning has a great impact on my self-confidence.
- 3-When I have difficulties in English learning, I begin to doubt my own ability.
- 4-Whenever I have overcome a difficulty in English learning, I can feel my own growth.

#### *Additive change*

- 1-I can easily switch between Persian and English according to situational needs.
- 2-I am relatively confident when speaking in English, and relatively modest when speaking in Persian.
- 3-I prefer to listen to the original English dialogue when watching English movies, just as I enjoy the original Persian dialogue when watching Persian movies.
- 4-I have an English name in addition to my Persian name. They are used in different situations.

#### *Subtractive change*

- 1-With the improvement of my English proficiency, I feel my Persian is becoming less idiomatic.
- 2-After learning English, I feel my behaviors have become somewhat Westernized.
- 3-After learning English, I have developed repugnance to some Persian conventions.
- 4-After learning English, I have begun to reject some traditional Persian ideas.

#### *Productive change*

- 1-With the improvement of my English proficiency, I can better appreciate the subtleties in Persian.
- 2-After learning English, I find myself more sensitive to changes in the outside world.
- 3-After learning English, I have become more understanding and can better communicate with others.
- 4-As my ability of appreciating English literature and arts increases, I have become more interested in Persian literature and arts.

*Split change*

- 1-I feel weird when my speech in Iranian is subconsciously mixed with English words.
- 2-I feel a painful split when I switch between English and Persian behavioral patterns.
- 3-When parting with foreign friends, I'm frequently confused as to whether I should shake hands or hug and kiss.
- 4-After learning English, I'm often caught between contradicting values and beliefs.

*Zero change*

- 1-No matter which language is used for expression, I remain to be myself.
- 2-I have not felt any change in myself after learning English.
- 3-An instrument is an instrument. It is impossible for me to change into another person after learning a language.
- 4-For me, it is meaningless to talk about personal changes after learning English.

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# **Design and implementation of 3D printer for Mechanical Engineering Courses**

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## **Abstract**

*Nowadays 3D printing is a hot topic and this was specially observed during the COVID-19 pandemic. Hence, this project has the objective to present the design and implementation of a 3D printer, which fits the Mechanical Engineering Courses requisites. The founded solution follows the Delta architecture and it was called Delta MAPL. This paper will summarize all important definitions and knowledge to build a 3D printer such as, 3D printers technologies and architectures, expose the developed project involving mechanic and electric project, project cost, programming and slicer, calibration, printing parameters, and will also expose de results through implementation of the project, 3D printing tests, and also the documentation with all design parts, codes and printing parameters. Therefore, 3D printer is very useful and involving many fields of Mechanical Engineering knowledge, thus 3D printing develops not only knowledge in mechanic, electric, sensors and actuators and material properties, but also creativity and problem-solving that are so important for all engineering students.*

**Keywords:** Delta 3D printer; Mechanical Engineering Courses; Delta MAPL.

## **1. Introduction**

Nowadays, the new Industry revolution, usually called Industry 4.0, refers to the emergence and diffusion of a range of new digital industrial technologies as Internet of Things (IoT), Big Data and Analytics, Robotic, and Additive Manufacturing (3D printing). On this way, the 3D printing has lots of advantages, such as, it is more available than traditional manufacturing, the products can be more customized compared to traditional process, it has relatively easy production of complex parts, it also has little or no waste of raw material, and the processes can be reversed as others additive process by remelting the material with the

filament shape. However, there are some issues, such as, higher production time, inefficiency, higher cost, lower precision, lower resistance mechanic and thermic, comparing to subtractive processes (Strange and Zucchella, 2017).

For this reason, diverse enterprise and communities investing in 3D printer (Stratasys, Markerbot, Prusa and RepRap), 3D slicers (Simplify3D, Cura, and IdeaMaker) and repositories of parts (Thingiverse, CGTrader and Cults) for industrial and domestic users.

Due to COVID-19 pandemic the use of 3D printer increased. Many open-source designs of medical equipment and personal protective equipment (PPE) were developed by communities for combat against COVID-19, by printing protective masks, face shield, ventilator systems and valves (Belhouideg, 2020). These parts can be manufactured anywhere that have a 3D printer available, so it is ideal for small, diversified and local production (Strange and Zucchella, 2017), furthermore, 3D printing can reduce the burdens of trade tariffs and transportation costs (Laplume et al., 2016).

To accelerate the development of 3D printing, RepRap was created in 2005. It is a community to develop self-replicating manufacturing machine, normally use lots of 3D print parts and low-cost material to build this 3D printers, the projects are open source, so, it is freely available for anyone. They say that “the most important thing you can print in a 3D printer is another 3D printer” (RepRap, 2020). This project follows RepRap’s project, therefore it is open source and easy replicable, too.

On this way, there are lots of ‘Do It Yourself’ (DIY) 3D printer kits to buy, and the user can build his/her own 3D printer. This is one of the lowest way to buy a 3D printer and a good way to learn how it works (Best DIY - All3DP, 2020). A survey answered by teacher who use 3D printer in the classroom inform that the students developed many skills while working on 3D printing projects, including 3D modeling, creativity, technology literacy, problem-solving, self-directed learning, critical thinking, and perseverance (Trust and Maloy, 2017).

In addition to these skills, the use of 3D printers on the engineering courses is important to aid the extensions project to develop their projects and to assist the students on the Computer Aided Design (CAD) classes. Furthermore, the study of the use and how this machine works involves many engineering subjects which can help in the education of the student, such as, manufacturing processes, metrology, elements of mechanical construction, kinematic system, power transmission, electric, sensors and actuators, heat transfer, thermoplastic, mechanical properties, mechanic of solids, among others.

This paper will present the main concepts to know to develop a 3D printer in the bibliographic review. After that, the methodology will explain how this project was developed through the requisite analysis. The chapter of 3D printer design explains the specification of the printer, presenting the mechanical and electrical project, necessary components, programing, calibration, and total cost of this 3D printer. In the next section it is showed the implementation of the 3D printer, its tests, and the open documentation for future improvements of this project.

The main objective of this paper is to develop the design and implementation of a 3D printer to illustrate all the engineering areas that are essential to learn and how this new technology can aid in the process of education in diverse engineering courses, especially in the in aeronautical, mechanical and mechatronic courses. This paper will not have a focus on the 3D printed parts accuracy and quality surface.










## 2. Bibliographic Review

### 2.1 Additive Manufacturing

Additive Manufacturing (AM) is a technique of manufacturing which use CAD to build objects layer by layer (ASTM, 2020). There are seven categories according American Society for Testing and Materials (ASTM) and many technologies as Table 1 shows.

Table 1. Categories of additive manufacturing according to ASTM. (Nazir *et al*, 2019)

Categories	Technologies	Advantages/Drawbacks
 Vat-Photopolymerization	<ul style="list-style-type: none"> <li>SLA</li> <li>DLP</li> <li>CLIP</li> </ul>	<ul style="list-style-type: none"> <li>High Building Speed</li> <li>Good part resolution</li> <li>Overcuring, scanned line shape</li> <li>High cost for supplies and materials</li> </ul>
 Material Jetting	<ul style="list-style-type: none"> <li>Polyjet</li> <li>MJP</li> </ul>	<ul style="list-style-type: none"> <li>Multi-material 3d printing</li> <li>High surface finish</li> <li>Low-strength material</li> </ul>
 Material Extrusion	<ul style="list-style-type: none"> <li>FDM</li> <li>FFF</li> <li>ADAM</li> </ul>	<ul style="list-style-type: none"> <li>Inexpensive extrusion machine</li> <li>Multi-material printing</li> <li>Limited part resolution</li> <li>Poor surface finish</li> </ul>
 Binder Jetting	<ul style="list-style-type: none"> <li>MJF</li> <li>SPJ</li> </ul>	<ul style="list-style-type: none"> <li>Full-color objects printing</li> <li>Require infiltration during post-processing</li> <li>Wide material selection</li> <li>High porosities on finished parts</li> </ul>
 Powder Bed Fusion (PBF)	<ul style="list-style-type: none"> <li>SLS</li> <li>SLM</li> <li>DMLS</li> <li>EBM</li> </ul>	<ul style="list-style-type: none"> <li>High accuracy and details</li> <li>Fully dense parts</li> <li>High specific strength</li> <li>Powder recycling</li> <li>Support and anchor structure</li> </ul>
 Directed Energy Deposition (DED)	<ul style="list-style-type: none"> <li>LENS</li> <li>EBAM</li> <li>LMD-w</li> <li>WAAM</li> </ul>	<ul style="list-style-type: none"> <li>High deposition rate compared to PBF process</li> <li>Repair of damaged/worn parts</li> <li>Functionally graded material printing</li> <li>Require post-processing</li> </ul>
 Sheet Lamination (SL)	<ul style="list-style-type: none"> <li>LOM</li> <li>UAM</li> </ul>	<ul style="list-style-type: none"> <li>High surface finish</li> <li>Low material, machine, process cost</li> <li>Decubing issues</li> </ul>

SLA stereolithography, DLP direct light processing, CLIP continuous liquid interface production, MJP multijet printing, FFF fused filament fabrication, ADAM atomic diffusion AM, MJF multijet fusion, SPJ single-pass jetting, DMLS direct metal laser sintering, LENS laser engineered net shape, EBAM electron beam AM, LMD-e laser metal deposition with wire, WAAM wire arc AM, LOM laminated object manufacturing, UAM ultrasonic AM

Among these technologies, one of the most prominent are FDM (Fused Deposition Modeling), SLA (Stereolithography) and SLS (Selective Laser Sintering). All of them have advantages and disadvantage when comparing dimensional accuracy, time printing, cost, surface finish and mechanical properties. These features are presented in next subsections.



### 2.1.1 3D Printer's Technologies

#### 2.1.1.1 FDM

This is one of most famous 3D printer technology. This mechanism is very simple, its similar to the hot glue gun. A filament of polymeric material is softened and melted with the aid of heat and is extruded, so, the material is pushed and forced through a nozzle of reduced diameter and then deposited layer by layer on the building platform or bed (Calignano *et al.*,2017), as shown in Figure 2. The filament has usually a standard diameter of 1.75 mm or 3 mm and it is supplied by a filament spool which can use many materials such as Acrylonitrile Butadiene Styrene (ABS), Polylactic Acid (PLA), Polyethylene Terephthalate Glycol (PETG), carbon fiber and nylon.

This technology has lots of benefices, it is simpler, the printer and the material aren't expensive, normally shorter time to print and to configure the machine, and many possibilities of material with different properties (Choudhari and Patil, 2016) (Sculpteo, 2020). Although the surface finish and dimensional accuracy is not got.

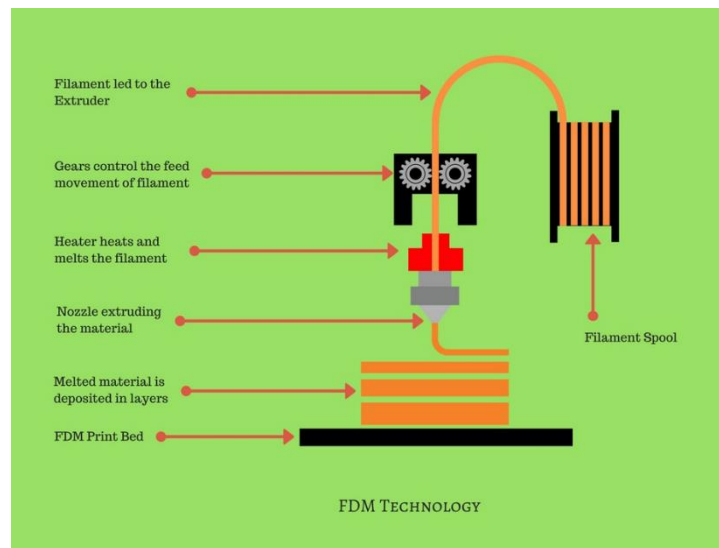


Figure 2. FDM mechanism of printing. (Manufactur3D,2018)

#### 2.1.1.2 SLA

Similar with FDM, this technology also builds the object layer by layer by making 2D drawings. Therefore, these layers are built with a UV laser which will solidify a liquid photopolymer resin which is photosensitive (Sculpteo, 2020) (Gibson *et al.*, 2010), as shown in Figure 3. This is the best technology for high surface finish and dimensional accuracy; however, the resin can be very expensive and normally has fragile fracture (Choudhari and Patil, 2016) (Sculpteo, 2020).

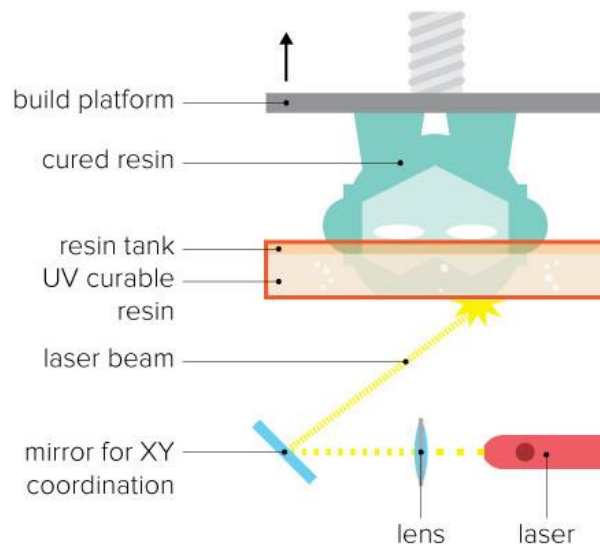


Figure 3. SLA mechanism of printing. (3Dream, 2021)

#### 2.1.1.3 SLS

This technology is usually reserved for professional companies. The idea is also generating the part layer by layer by making 2D drawings. However, this time the laser will sintering together powder particles in the shape of the cross-section by heating and the building platform will go down for recover with other layer of powder (Sculpteo, 2020) (Gibson *et al*, 2010) (Legutko,2018), as shown in Figure 4. There are many advantages, for instance highest durability of the parts, lots of options of materials and it doesn't need to use supports. Therefore, the cost of the 3D printer is very expensive and the system is more complex. (Choudhari and Patil, 2016) (Sculpteo, 2020).

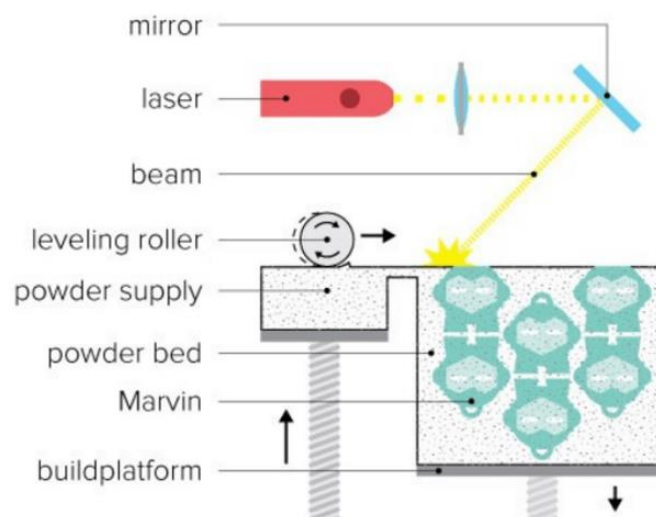


Figure 4. SLS mechanism of printing. (3Dream, 2021)

#### 2.1.2 FDM 3D Printer's Architectures

Normally the FDM printers are classified in reason of the mechanical system and kinematic, there are lots of 3D printer types, for example: Cartesian, Delta, CoreXY, H-bot, polar, SCARA, and belt (O'Connell,

2020). The three architectures most found are Cartesian, COREXY and Delta, hence, the focus will be in these models. The comparison between these printers is hardly found in articles. Nevertheless, there are many sites and forum of 3D printer that make this comparison.

The Cartesian model has the X, Y and Z controlled separately like in the Figure 5 are called Cartesian. Thus, it uses normally one motor for X axis, other motor for Y axis and two motors for symmetry in Z axis. Due to this independent of each axis, it has the easiest calibration, assembly and found troubleshoot in sites and forums. Nonetheless, it is the most limited architecture, lower limit speed of printing, more vibration and inertia, and impossibility to print tall parts, due to the movement of the printing bed in Y.

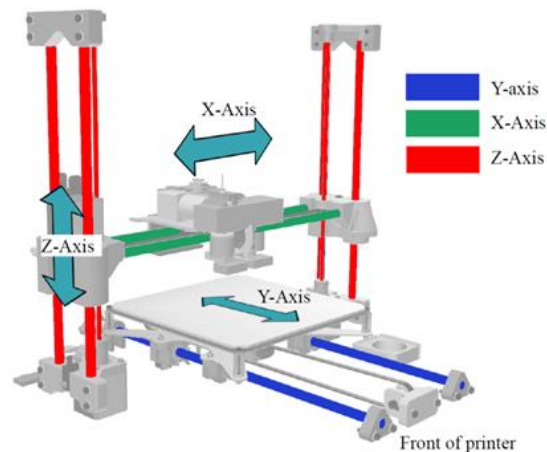


Figure 5. Illustration of Cartesian printer. (Cartesian3D, 2019)

The COREXY is very similar with cartesian, however the Z movement is due to the movement of the bed by two motors and the X and Y axis movements are determined by the control of two motor which works together by a belt association (Figure 6). Each belt color (Figure 6) is associate with your respective motor. Is a good printer to work in the XY plane, high printing speed, can print higher parts than cartesian due to the only Z movement of the bed. However, is the most expensive one in reason of the necessity of a more robust structure and more rigid table due to the vertical movement, moreover, the process of calibration is more difficult than Cartesian, because there are two motors which works together.

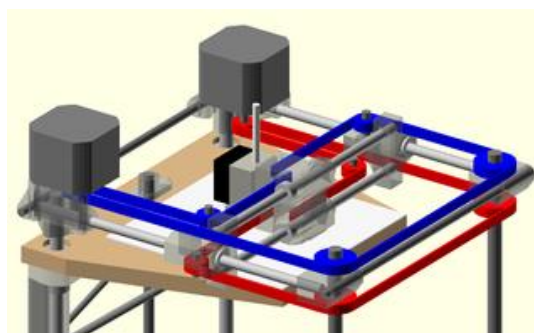


Figure 6. Illustration of COREXY printer. (CoreXY - RepRap, 2020)

Among the three architecture the most different kinematic is the Delta one. the movement of X, Y and Z axis is due to three motors, one in each tower which work together to move the axis in vertical, as illustrate in Figure 7. This structure is the simplest, use only three motors for movement instead of four, as the others

models. Enable to print tall parts due to its height and the static print bed. Moreover, this kind of printer is easily extended in Z direction without redo the project. Can move in Z direction faster because it doesn't use thread bar or spindle. The move system is lighter, because it only uses delta arms, the hot end and the effector, so it results in lower inertia, enable high printing speed and use stepper motor with less torque. Furthermore, this structure takes up little horizontal space, making it easier to position it. However, due to this different kinematic, this is the most difficult architecture to calibrate and fix problems, it is worse to works in XY plan, and has a small 3D printer area by reason of circular bed.

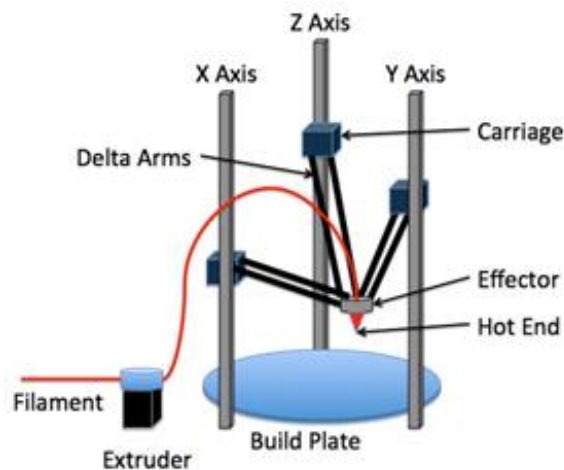


Figure 7. Illustration of Delta printer (Bell, 2015).

### 3. Methodology

#### 3.1 3D printer Requisite analysis

The aim of this project is to develop one machine which can be used by the Mechanical engineering courses to improve the student knowledge and aid the implementation of many projects. Thus, it will be necessary the use of one kind of manufacture which is relatively cheap to implement, produce very complex parts at low cost, allows rapid prototyping for customized parts and small batches, it can be achieved by the additive manufacturing (AM) (Attaran, 2017).

There are lots of AM technologies, however, for this project was chosen the fused deposition modelling (FDM), by reason of it provides a range of raw material with different mechanical properties for many applications, it is cheaper compared with the other technologies, and the process of fabrication is relatively simple (Calignano *et al.*, 2017).

To choose the type of the FDM printer it necessary to establish the requirement of this project. It will be analyzed the cost of printer with the same printing volume, printing time, printing accuracy, superficial quality, printing volume in relation with printer volume, facility to calibrate and fix problems and facility to enclosure the structure.

With the aim of choose the best printer to build for the conditions of this project, distinct weights for each factor were assigned. The cost is the most relevant so the weight is five, printing time, accuracy and superficial quality are very important so the weight is three, and the other factors are less reelevates for the

aim of this project, so it was given one.

The color of each factor for each printer is in reason of the advantages, the green is the best and will score five points, yellow is the intermediary and will score three points, and the red is the worst and will score one point. The final score of each printer is the sum of all color point multiplied by their weight. All these characteristics were analyzed based in the experience of the MAPL (Manufacturing Automated Planning Laboratory), information on the internet and articles in the literature.

The cost of printer with the same printing volume is the most important, because if the printer is cheaper the university can build more machines for the education laboratories. The COREXY is the type the most expensive to build and to buy due to the necessity of high structural stiffness, in comparison Cartesian has a simple structure and Delta uses one motor less and has less components made them cheaper. Printing time is another crucial parameter, because normally 3D printers are not fast and the long printing spends hours. Delta and COREXY allow faster printing due to lower inertia of the carriage beyond static bed for Delta and only slow vertical movement of the bed for COREXY, it gives less vibration in faster printing. Accuracy is so important in mechanical projects to guarantee clearance or interference fits. Due to three conjugate motors for Delta and two for COREXY, the geometry of the structures needs to be most near of a square for COREXY and equilateral triangle for Delta. Thus, the tolerance of the components used and the assembly process interfere in the accuracy mainly for Delta after for COREXY. The superficial quality is very important to reduce energy losses due to the friction, smooth 3D printing avoids the necessity of a superficial finish. Due to the less vibration in COREXY and Delta the pieces are smoother. (O'Connell, 2020) (Creality, 2021) (Tractus3D,2020) (Sampaio, 2017) (Fabbaloo,2020) (Schmitt *et al.*, 2017)

Besides that, printing volume in relation with printer volume is important to reduce the volume the printer occupies in the lab. Cartesian has the worst relation due to the horizontal bed movement, after COREXY because of robust structure and Delta is the best because it occupies a low area on the floor or on the table and it is tallest. The calibration and fix involve, mechanical and electrical fix besides mechanical calibration and calibration by software mainly for stepper motor and end stop sensors. The cartesian is the best due to simple kinematic and large troubleshooting on the community. The COREXY, Delta is more difficult to calibrate due to conjugate motors system as explained in accuracy problem. Lastly, the facility to enclosure, enclosure the printer is important to imprint material which have high retraction when cooled, enclosure can avoid warping problem and improve the superficial quality. The COREXY is the easiest to enclosure due to the cubic geometry, after Delta because of towers, and Cartesian normally needs to build a full box to enclosure it. (O'Connell, 2020) (Creality, 2021) (Tractus3D,2020) (Sampaio, 2017) (Fabbaloo,2020) (Schmitt *et al.*, 2017)

Among the three models is possible to see that Delta reach the highest score (67, as presented by Table 2) with this specific requisite analysis. Which the cost, printing time, accuracy and superficial quality are the most important parameters. In other application for example when the cost isn't so important, the COREXY is a good choice. And when the focus is a cheaper printer and easy printer to use the Cartesian is a good choice. Hence, the decision of the best printer depends on the application and the desired requirements.

After choose the 3D printer architecture is possible to start the development of the 3D printer project with the Delta type, called Delta MAPL.

Table 2. Comparative of requisite analysis between Cartesian, COREXY and Delta.

Printers	Cost (5)	Printing Time (3)	Accuracy (3)	Superficial Quality (3)	Printing Volume/Printer Volume (1)	Calibration and Fix (1)	Enclosure (1)	Score
Cartesian	Cheaper	Slower	Good	Less Smooth	Smaller printing area and can't be height / Big printer area	Simple and Large Community	Harder	53
COREXY	Expensive	Faster	Depends on the assembly	Smooth	Big printing volume / Big printer volume	XY conjugate motors (perfect square)	Easy	55
Delta	Cheaper	Faster	Normally vary in printing bed	Smooth	Smaller printing area tall height / Small printer area tall Height	XYZ conjugate motors (perfect triangle)	Medium	67

## 4. 3D printer Design: Delta MAPL

### 4.1 Structural Project

To develop the structural project is necessary understand the kinematic of the Delta printer. The relation between the speed of each tower and the speed in cartesian axis X, Y and Z is found in the literature and is a complex matrix which depends on the position of each tower and the size of the printer (Williams, 2016). Furthermore, it is important to know that how far the printer is in relation of the center of the bed, lower is the angle of delta arm with the horizontal resulting in faster speed due to the kinematic, causing instability and losing accuracy. Hence, it is important to know that to know the limit of movement of the printer (Delta geometry - RepRap, 2019). By this reason the minimum angle was defined as 20° to limit the multiplier of speed in 2,75, as shown in Figure 8.

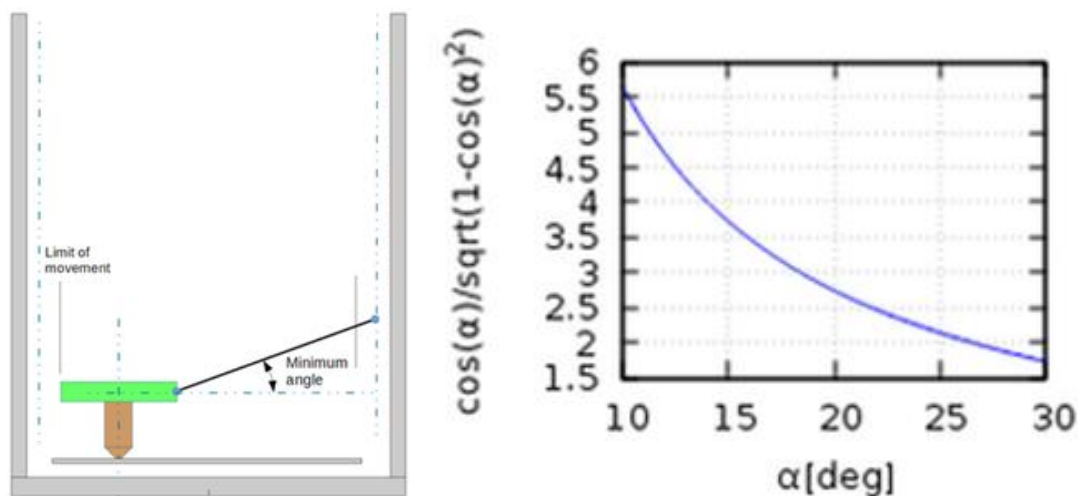


Figure 8. Relation of the angle of the arm and the multiplier of speed (Delta geometry - RepRap, 2019).

The delta heat bed has 22 cm of diameter but only 20 cm of heat zone. Applying the minimum angle as 20° the useful diameter will be 17 cm. Besides, the height of the printer is defined to achieve the printing volume with a cylinder with 38 cm of height and a cone on the top with 2 cm of height, as shown in Figure 9. This cone zone is not good to print because the arm may hit the top of the printer. For this reason, the printing volume considered is the cylinder with 38 cm of height and 8,5 cm of radius resulting in 8625 cm<sup>3</sup>.



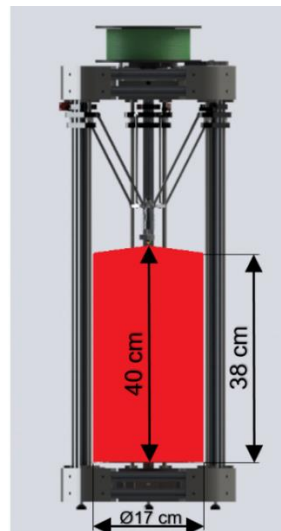


Figure 9. Printing volume of the Delta MAPL

After define the printing volume the CAD was developed, the first version of the printer has only aluminum profile in the tower and the bottom and the top are aluminum plate, however the stiffness of the aluminum plate is not high besides it is expensive to buy this plate cut by an CNC (Computational Numerical Control). Thus, it was done many changes to increase the stiffness of the structure without increase the price as shown in Figure 10.

This final version has two aluminum profile with 20 mm x 20 mm and they have a distance to increase the momentum of inertia, this solution is more rigid and has a close price than use just one 30 mm x 30 mm aluminum profile. Furthermore, all corners of the triangle are 3D printed and can be printed in other printers, the motors of the tower are hidden on the bottom besides the structure is more compact in area and height. To guarantee the linear movement of the carriage at the tower it was used two smooth rods for each tower and a linear bearing was placed in the carriage (Figure 11). Theses smooth rods also increase the stiffness of the structure. It was used a screw that went through the corners parts to guarantee the fixation of the parts in addition to preventing the pieces from breaking by shearing layers.

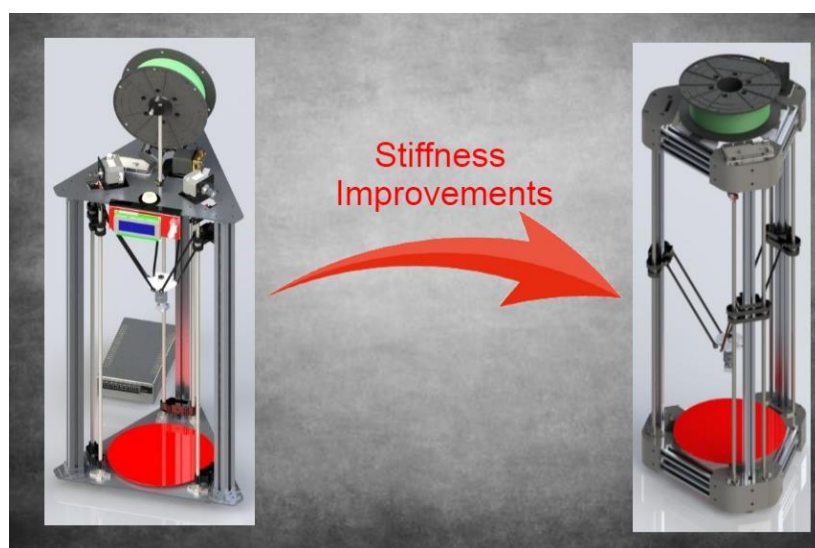


Figure 10. First version and last version of the Delta MAPL with stiffness improvements.



Figure 11: Relevant dimensions for internal calculation of printer kinematic

To adjust the tension of the belts which promotes the carriage movement it was developed as simple system which can vary the length of the belt by adjusting two screw (Figure 12). Moreover, the most used screws in this 3D printer have been the allen type, because this screw can be adjusted in locations of difficult access.

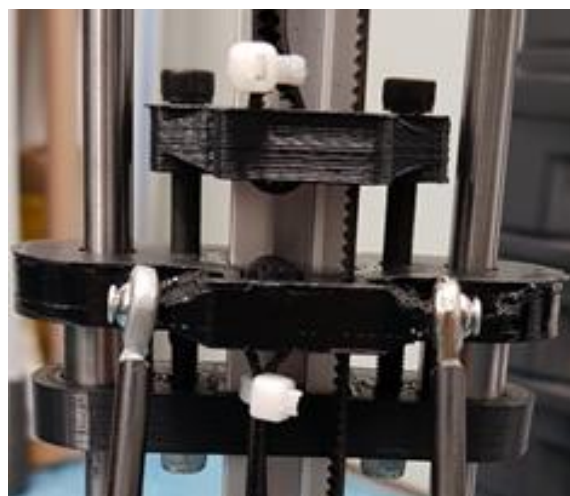


Figure 12: Adjusting tension system developed.

## 4.2 Electric Project

The electric project independently of the architecture of the printer is very similar. Normally is used the microcontroller Arduino Mega 2560 which is compatible with the firmware *Marlin* and a shield called RAMPS is used to aid connect the other electric components, as shown in Figure 13. In this case it was used the RAMPS 1.4.

In the wiring illustration of this 3D printer, it is possible to observe many components, there are four stepper motors which are responsible to promote the movement of the carriages of each tower and the extrusion of the filament, each motor needs a driver to aid in the control of the motor and enable the microsteps movements. There are three end stop sensors, one for each tower to inform the origin of the system and the max range in Z direction.

Furthermore, there are the heater extruder (hotend) which will melt the filament. There are two fans and their function are to cool the hotend and the RAMPS. Moreover, there are the heater bed that function is heat the bed. There are two thermistors to measure the temperature of the hotend and the bed. Finally, there are a switching power supply to give the energy for components.

Due to high current demanded by the bed heater it was used Heatbed HA210N06 MOSFET Module connecting the switching power supply to the bed heater (Figure 13), to reduce the energy in the RAMPS. In this illustration there is one LCD monitor which hasn't been used on this project; however, it can be implemented further, because the LCD enable print objects without the computer, use only a SD card.

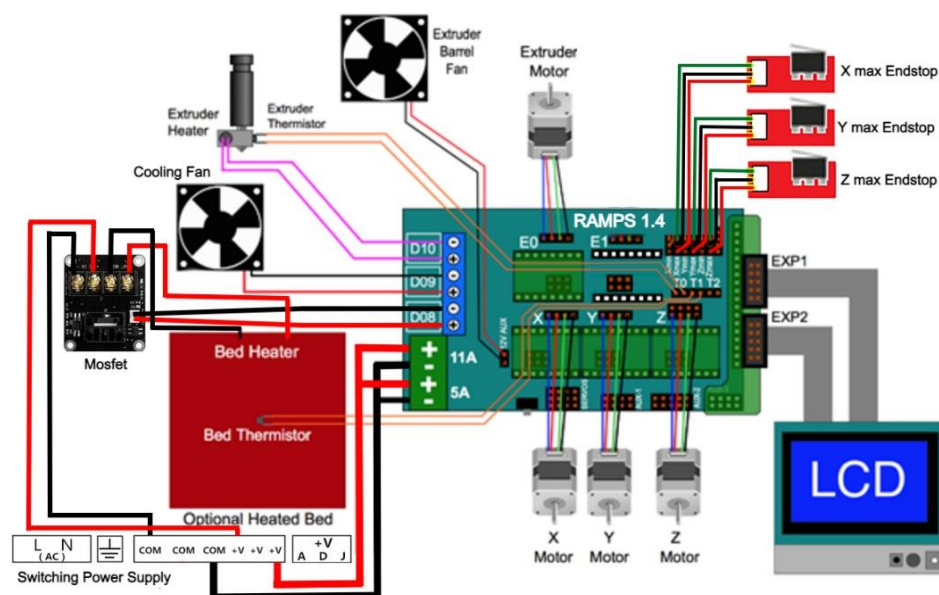


Figure 13. Electric wiring diagram of the printer.

## 4.3 3D Printer Cost

After defining all mechanical and electrical components it is possibly present the total cost to build the DELTA MAPL 3D printer. The Table 3 below has the cost including the shipping of all components, it also has one 1 kg of ABS which will be used to make the printer test and 2 kg of ABS to print all printed parts. The total cost of around R\$ 2,000.00 is lower than another printer with the same printing volume in Brazil.

Table 3. Costs of all used materials

Items	Quantity	Cost with Shipping
3D Printed Parts	2 Kg	R\$150.00
Aluminum Profile	4.848	R\$164.57
Arduino Mega + Ramps + Drivers + LCD	1	R\$169.86
Bearing 608zz x 10	1	R\$47.89
Belt + 4 Pulley	1	R\$87.90
Delta Arm x 6	1	R\$71.51
Endstop	3	R\$40.30
Extruder	1	R\$66.80
Filament	1	R\$104.84
Furniture Leveling Feet	3	R\$6.00
Glass	1	R\$15.00
HA210N06 Mosfet Module	1	R\$52.35
Hammer Nuts	42	R\$67.20
Heat Bed	1	R\$88.35
Hellermann Cable Ties	10	R\$5.00
Hotend + Cooler + Nozzle	1	R\$61.90
Hotend Support	1	R\$84.90
Linear Bearing Lm8uu x 6	1	R\$42.80
Motor Support	1	R\$37.20
Nema 17 Motor	4	R\$239.96
Screws + Washers + Nuts	Many	R\$45.00
Smooth Rods 700 mm x 8 mm x 6	1	R\$114.90
Smooth Rods Support	12	R\$133.29
Switching Power Supply 12 V 30 A	1	R\$68.90
Threaded Bar M5 and M8	3	R\$16.60
Wires + Heat Shrink Tube	Many	R\$10.00
<b>Total</b>		<b>R\$1,993.02</b>
<b>US Dollar (US\$)/Brazilian Real (R\$)</b>		<b>5.37</b>
<b>Total</b>		<b>US\$371.14</b>

#### 4.4 Programing and Slicer

It is important to know how the 3D printer works. For FDM printer the part is made in a CAD software, in this software the part is converted to STereoLithography (STL) format which is a surface of the object composed by many triangles. After that the user import this part to the slicer, and he can slice this part to generate the path of nozzle for each layer of printing. Following, the slicer generates the GCODE which is a language of CNC and inform to the printer in a text file all necessary information to print the object, as temperature of bed and hotend, speed of extrusion, and mainly the coordinates of the nozzle, as illustrated in Figure 14.

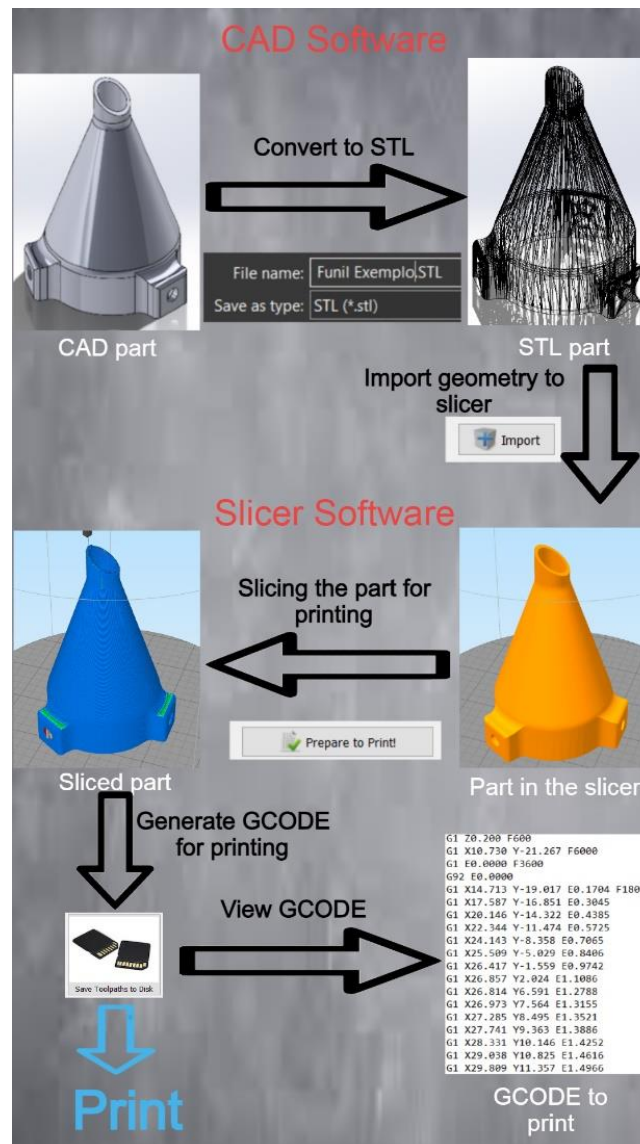


Figure 14. Schematic of how the slicer print a FDM part.

Programming the printer is a simple task, because there are many firmwares such as *Repetier*, *RepRap* and *Marlin*, they have all functions implemented and the user only need inform which functions he wants activate and give the parameters. In this phase the user informs, the printer type, the direction of rotation and step of the motor, the kind of thermistor, the dimensions of the printer, in this case of delta, arm length, delta radius and print radius (Figure 11), and other information. For this project the firmware chose was *Marlin* due there are more documentations and information in forums, besides that it has many GCODE functions and implemented functions.

Furthermore, it is possible to program a starting and ending script by GCODE to make the printer repeat this task all times after and before a printing. For this project the starting script the GCODE was implemented to configure the printer parameters of geometry, and the nozzle cleaning by a programmed motion of the nozzle on the bed. For the ending script the GCODE was implemented to turn off the heater of the bed and of the hotend and disable the motors.



#### 4.5 Calibration

Calibration is one of the most difficult phases for delta printer, because all motions in this architecture depends on the movement of all motors, besides that the motion of the printer is calculated based in the geometry of the printer. Thus, if the towers are not an equilateral triangle or the arms have different length or other variations, the calculated movement is not the real movement.

The simplest calibration process is the step/mm of the motor, this valor is normally informed by the user in the programing, but can be changed by GCODE after. This calculation is simple and depend on the motor step angle, the belt pitch, pulley tooth count and driver micro stepping. By the mechanical relations of power transmission, it is possible to result in the Equation 1 which can calculate the motor step/mm. There is a fine calibration to improve the accuracy of the printer, it is based in measure the external dimensions of a cube in X, Y and Z directions and increase or decrease the step/mm by the same proportion of the relation of nominal size and real size in each direction (Equation 2). But, for delta printer it isn't possible, because in delta the three motor must have the same step/mm, furthermore this fine calibration is not recommended because the user changes the theoretical calculated step/mm to another which depends only on the external dimension of the part.

$$Step/mm = \frac{360}{(Motor\_step\_angle * Driver\_microstepping) * (Belt\_pitch * Pulley\_tooth\_count)} \quad [1]$$

$$New_{step/mm} = Old_{step/mm} * \frac{nominal\_size}{real\_size} \quad [2]$$

Moreover, one of the most important calibration is the printing of the first layer, because the bed is a plane, but the real movement of a delta not ideal isn't regular due to the variations in the real geometry. To reduce this problem a set of three screws was placed to adjust the angle of the table plane. This is one of the most famous calibration. However, for delta it is not sufficient, the position of the three ends stop sensors change the kinematic of the printer. To solve this problem an offset of distance was made by GCODE with the function M666 to change the reference of the position of the end stop sensors. Besides that, to adjust the distance between the nozzle and the bad the height of the printer was set as 390.90 mm and to adjust the concavity of the nozzle motion the delta radius was set as 103.3 mm by the M665 command.

#### 4.6 Printing Parameters

There are many printing parameters, and they vary with the used slicer. This is one of the most important tasks to print a part, because this is not only for a person who develops a 3D printer but also for those who buy a printer, besides that these parameters can change the mechanical properties of the part, superficial quality, printing time, accuracy and other factors.

The 3D printer parameters can change the flow of the material in the nozzle, are relevant, and these parameters may change with the material used to print. Thus, the hotend temperature is important because higher temperatures will reduce the viscosity of the material and will increase the material flow and will impact also in the adhesion of the layers, another important parameter is the printing speed, low speed can increase the superficial quality and the accuracy of the part and high-speed permit print the pieces faster



but will demand a high material flow. Moreover, it is possible to increase the layer height and the width of the path, it will permit print the pieces faster, but with a worse resolution decreasing the accuracy and superficial quality. There are many other parameters to change but it is not the aim of this paper.

## 5. Results

### 5.1 Implementation

The printer was implemented as the expected in the CAD software (Figure 15). All printed parts were printed in ABS, the firsts parts were printed more than one time to adjust the clearance or interference fits between the parts. But after that was observed a systematic error in all holes around 0.25 mm than the nominal dimension, maybe in reason of the retraction of the material. To solve this problem all holes which cannot have an interference fit where increased in 0.25 mm. There is a function called horizontal size compensation but it is not recommended because it changes the external dimension too.

To reduce the quantity of wires outside the printer it was placed all wire of the motors and of the mosfet inside the aluminum profile to the RAMPS. Unfortunately, there are many wires in a 3D printer and disappear with most of them is really difficult, mainly in RAMPS.

It was implemented also a support for the filament spool with bearing on the top of the printer to reduce the energy losses (Figure 15). There is also the regulation of belt tension (Figure 12) and the regulation of the angle of the table plane by the rotation of the small white pieces in Figure 16. Moreover, due to the mechanical project the printer is very rigid and has little vibration, this increases mainly the surface quality of the printed parts (Figure 15).

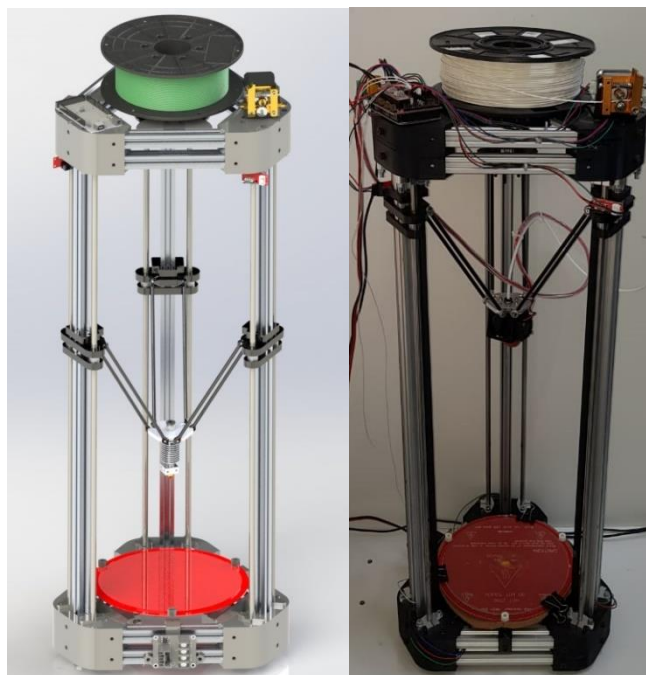


Figure 15. Final version of 3D CAD and the implemented project of Delta MAPL.

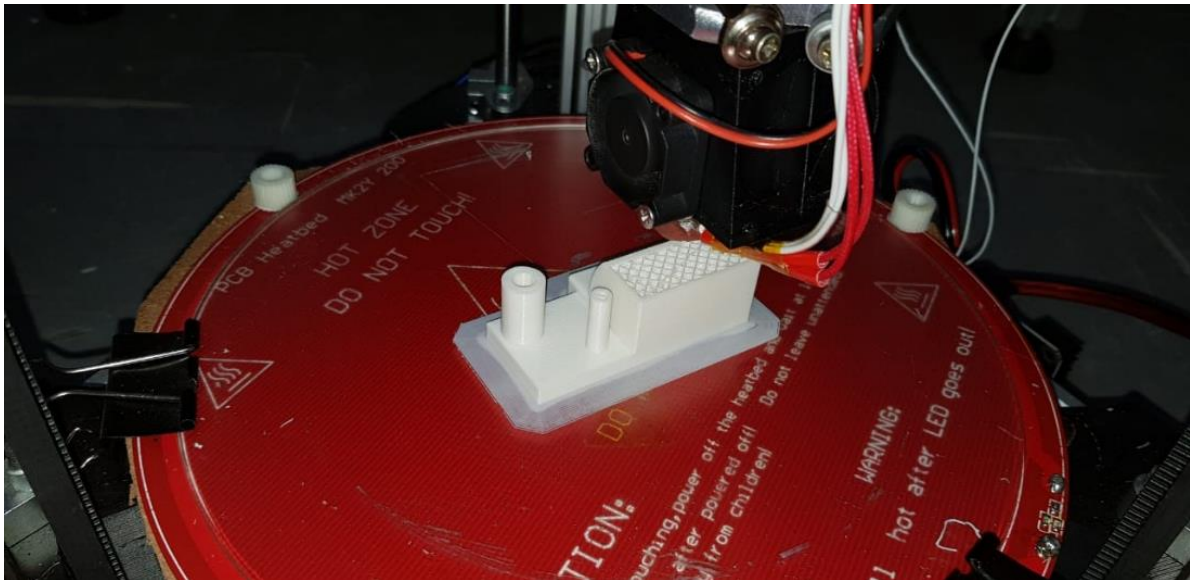


Figure 16. Deltar printer printing the test part.

### 5.2. Tests

To validate the Delta MAPL printer, it was used a printing test part developed in the MAPL with printing speed of 60 mm/s. This part has many different surfaces like a shaft, a hole, a curvature, and many planes (Figure17). This printing allows to analyze the surface quality and allows acquire different measures to analyze the accuracy. On this way the surface quality is very smooth and the accuracy of the printer varies according to the measures, the biggest dimension of this part has 60 mm, the difference between the nominal and real dimension on the heigh and the diameter of the shaft if smaller than 0,05 mm, but for  $X$  and  $Y$  dimensions the error is greater and with an average of 0.50 mm.

These results of surface quality and accuracy was expected due to the non-ideal geometry of the printer and the information on the Table 1. But this accuracy error can be mitigated by using a sensor of auto leveling of the bed.



Figure 17. Printing test part for validation of the project

### 5.3 Documentation

The open-source projects of 3D printing have been crucial to the development of the technology. For this reason, all essential information of this project, such as CAD parts, configuration of slicer and *Marlin* code were shared in two open-source site of CAD projects and 3D printing parts, in GrabCAD (<https://grabcad.com/library/delta-printer-mapl-1>) and Thingiverse (<https://www.thingiverse.com/thing:4562522>) respectively. Thus, the community can implement this project freely and anyone can improve this project and reshare with the community, it is the best way for dissemination of knowledge of 3D printer and aid to improve this technology.

## 6. Conclusion and Further Works

The objective of this project was successfully achieved, which was design and implement a 3D printer for mechanical engineering courses. This printer can printing parts in a relatively short period of time with smooth superficial quality due to delta architecture, which promote the use in several application such as prototyping and final use parts. All developed parts and used codes and printing configurations are available in GrabCAD (<https://grabcad.com/library/delta-printer-mapl-1>) and Thingiverse (<https://www.thingiverse.com/thing:4562522>).

The development of this project involves many knowledges that are essential of mechanical engineering students, such as 3D modeling, manufacturing processes and heat transfer to drawing and manufacture the parts, besides elements of mechanical construction, kinematic system, power transmission to make the design and assembly of printer, beyond mechanical properties, mechanic of solids and material properties for increase the stiffness and optimize the parts, as well as the electric, programming, use of sensors and actuators to choose the best component for the application and make the connections and control of all these components. Furthermore, it covers other areas of knowledge not well developed in the engineering courses such as creativity, problem-solving and practical knowledge mainly in mechanic and electric.

For future works it will be implemented an LCD display and auto leveling sensor to make the experience with the user easier and improve the accuracy of the parts. Moreover, it will be implemented an enclosure structure with acrylic sheet to reduce the effects of warping in ABS parts, as well as the writing of a guide book for 3D printer users.

## 7. Acknowledgement

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# **FACTORS THAT CONTRIBUTE TO THE SUCCESS OF THE BRAND IN THE INTERNATIONAL MARKET**

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## **Abstract**

*The internationalization process is defined as a gradual and constant system of involvement in the*



*company's negotiations with countries outside its origin borders. Therefore, it is a constant process that takes place in several stages and that can considerably increase the gains obtained from the company's operations regardless of its size. In this article, the objective was to analyze the factors that contribute to the establishment of national brands in the international market. For this purpose, the methodology adopted was a literary research involving a bibliographical survey. It was concluded that for the brand's internationalization process to be successful, the company must adopt a correct international market entry strategy, because this is considered an important step that can leverage the company in the future. It was observed that the internationalization is seen as a form of continuous learning in face of the competitions that exist in the international arena, something that involves time and risk.*

**Keywords:** Internationalization. Brand. Company. Market

## **1. Introduction**

The internationalization process can be defined as a growing and continuous procedure of involvement of the operations of a company with countries outside its home base. It treats an endless process that goes through several stages and can considerably expand the company's financial gains, regardless of its size. The internationalization decision has been a recurring subject in various business segments (DAL-SOTO, 2006).

In this segment, the internationalization process can also be characterized for the search of organizations to commercialize their goods, products and services, not only in the domestic market, but also to other nations. This process begins with an organization's initiative to export. At this first moment, its sales begin in small quantities, usually to nations similar to its own. After some time, they increase their sales, look for different nations, with different cultures, with the possibility of opening subsidiaries in some of them (PORTO, 2014).

Therefore, when deciding to launch itself into the international market, the company must be careful on choosing its target market. More sophisticated markets, such as the United States and Europe, are responsible for much of the global financial turnover, on the other hand, they have higher requirements and, as a consequence, are more difficult to get in. According to Stal (2010), choosing the internationalization is a strategic decision in which exportation is the first step, and may be the only one – in case the company just wants to get rid of the production surplus that the internal market does not absorb –, going beyond exportation through the different stages of the process requires a better and long-term planning.

In front of this reality, the objective of this study was to analyze how the national brands manage to establish themselves in the international market. It is understood that the process of entering the international market requires, besides a high financial investment, overcoming obstacles such as cultural differences, restrictions on the mobility of personnel, limitations for the technology transfer and national policies that restrict foreign capital, that is, the entrepreneur needs to face all these barriers in order to obtain acceptance and success in the international market.

The study was based on a literary research. First, the titles were read, then the abstracts, then the abstracts and the complete reading of all articles found to know if there was any relation to the research question, as

well as books related to the theme.

## **2. Marketing Strategies for the Success of the Brand in the International Market**

Welch and Luostarinen (1988, p.34-64) defined the process of internationalization of the companies as “(...) a process of growing involvement in international operations.” This definition would become complete if it did not refer only to the international operations, but also to the operations with international levels of competitiveness.

The Brazilian companies, even though they were already internationalized, became dependent on a series of economic changes and adjustments – a set of policies in the foreign exchange, financial and trade fields – in order to finally be able to operate internationally. These changes began to produce their results around 2004 with the transformation of the Brazilian economy into an emerging economy (LACERDA et al., 2010). Among the many actions developed, the one that had a fundamental impact was the transformation of Brazil into an attractive country to the entry of productive capital, that is, new international companies started to establish themselves in the country through their subsidiaries. However, the consolidation of Brazil in the international scenario also required the insertion of Brazilian companies in other countries. Thus, Brazilian companies with better economic conditions began to internationalize (LACERDA et al., 2010). The authors also note that the internationalization process is not restricted to a group of companies considered to be large-scale. Following the example of other countries, the small and medium-sized companies began to articulate themselves through consortia and productive arrangements to access international markets. In addition to the designation of the internationalization process, there are strategies for the company to achieve success in the foreign market.

Furrier (2008) suggests a series of measures to be adopted by a company before it begins the internationalization process: (1) to define goals for the brand in the countries in which it is intended to enter (brand management); (2) to assess whether the brand and the products are suitable for the entry market; (3) to ensure that the position in the domestic market is satisfactory, to the extent that the company can give due attention to the internationalization process (advantages of exporting); (4) to define a competitive strategy for entering the foreign market (export capacity); (5) to evaluate and allocate the human, financial and productive resources so that attention can be given to international operations; (6) to do a survey of the opportunities and threats of the internationalization plan (FURRIER 2008 apud MACHADO, 2013).

When organizations opt for the international market, they have to consider its advantages and disadvantages. Within this context, Maia (2003) considers as “disadvantages to internationalization the barriers arising from the differentiation of currencies, which makes international negotiations difficult; the barriers of conflicting legislation; as well as historical, cultural and structural factors”. For Minervini (2008), “although internationalization brings many benefits for the company and also for the country, before entering the foreign market, it is advisable to consider the barriers imposed by the international market”. Chart 1 lists some advantages and disadvantages of internationalization.

Chart 1 – Advantages and Disadvantages of Internationalization

<b>Advantages</b>	<b>Disadvantages</b>
Possibility of increasing the productivity of the exporting country.	The financial payback time may be longer.
Possibility of reducing the tax burden of the exporting company, due to the offsetting of the collection of national taxes.	The location causes climatic and cultural differences between countries, making it necessary, in some cases, to take greater care with exported goods, avoiding losses.
Usually, companies driven by Market trends (innovation, technologies, design) tend toward competitiveness in the domestic market.	If the company that intends to export is not qualified for the market, it is possible that the foreign trade will become a problem, given the bureaucratic and legislative issues that these activities involve.
Companies that export end up becoming stronger when there is success in the negotiations, becoming, then, a reference for companies that wish to be inserted in the foreign market.	Possible tax obstacles or transport problems can delay and hinder exports.
Increase of sales and profits.	Need for product adaptations.
Decreased dependence on the domestic market.	Need for a specialized team.
Improvement in the flow of idle capacity and less impact from seasonality.	Increased investment on marketing and logistics
Brand strengthening	The company has difficulty in knowing the modalities of product protection by intellectual property

Source: Prepared by the authors based on Maia (2003) and Minervini (2008)

In view of the above, Keller (2008) points out that it is important that brands in internationalization processes maintain, as far as possible, the strength and cohesion of their sets of brand elements, which are: name, logo, slogan, character, domain, jingle or sound signal, packaging (for products) or point of sale (for services). Thus, one of the primary factors for obtaining success in the international market is marketing construction.

The global marketing philosophy was born from the moment the companies that internationalized needed to have this differentiated look. Therefore, these multinational companies started to be considered global companies, for being present in several countries, creating products that could be consumed in different places around the world. There is a difference between being global and thinking global. By being global, companies will be installed in an important number of countries, and by acting and thinking globally, it means that the company's philosophy is to meet the needs of customers anywhere in the world. (KOTLER, 1998).

The global marketing strategy is seen as a means of exploiting the synergies that exist between the markets

of different countries, as well as the comparative advantages associated with various foreign countries. To be effective in global competition, the company must optimally develop its value chain activities and coordinate its efforts in different markets. Geographical distances, along with legal, political and cultural differences in different countries have been perceived as key factors for international marketing to earn its own space in the scientific literature (FURRIER, 2008 apud MACHADO, 2013).

The goal behind global marketing is to enable the company's products or services to reach new markets, on an international level, from an advertising and trading opportunity. Global marketing represents the contact stage of global branding with local markets. It is through international marketing strategies and the definitions of the marketing mix (price, product, place and promotion) that the brand's positioning and image are consolidated among consumers in each region. For this purpose, brands need to combine standardization and adaptation strategies in order to reconcile scale economy and adaptation to local realities (MACHADO, 2013).

Through marketing the company can verify its acceptance in the international market, that is, if its brand will be well accepted in this scenario, because the global marketing strategy must also establish the guidelines for the level of adaptation and standardization of the marketing program elements, based on the premise that the cultural differences in each foreign market demand an adapted and specific marketing strategy (KHAUAJA, 2012).

According to Czinkota et al (2002), international marketing retains the same basic fundamentals as national marketing; however, it takes place "beyond national borders". Also in accordance with Czinkota et al (2002), the international marketer "is subject to new macro-environmental factor, to different constraints and often faces conflicts resulting from different laws, cultures and societies. Thus, international marketing constitutes the process of planning and implementing transactions across national borders to enable exchanges that meet the objectives of individuals and organizations. Its forms range from export-import deals to licensing, franchising, partnerships, the full ownership of subsidiaries and management contracts. (CZINKOTA et al., 2002 p.74).

In this view, international marketing strategies, according to Rocha (2002, p.102), are "a process that begins with an analysis of a product or market opportunity. In this context, the author states that the international marketing strategy is based on the vision of the four Ps: product, price, place and promotion, in a view of adapting the international marketing strategy to local markets.

Another important factor to ensure the brand stability is the internationalization strategy and the decisions on how to enter foreign markets which are important, because they entail numerous risks and involve high resources, given the financial capacity of the companies. Thus, the basis of an internationalization strategy is the choice of the way of entering the target market, which can be between the limiting cases of indirect exports and foreign direct investment (MINERVINI, 2001).

For Mações and Dias (2001), for a brand to be successful, it is necessary to understand that internationalization are strategic decisions that involve the identification of the products to be placed in international markets, the markets it intends to reach and the most propiarte ways of access and presence. In other words, the internationalization strategy is based on the trade-off investment versus the degree of control of the external presence. In terms of international marketing, Brazilian companies need to develop a unique global brand identity, adapt their marketing mix, invest in recognition in foreign markets and

coordinate and measure the results of marketing actions (ROCHA, 2002). There is also a real need to worry about building the brand image in the foreign market, which is often unknown and has to be built up again in a positive way (KHAUAJA, 2012).

It is also observed that the manager of a company that operates in international markets is an essential element in the process of recognizing opportunities and risks existing in the country of origin and also across borders. The manager must also coordinate activities and unite capabilities across these border barriers, that is, have as a goal to capture benefits in operations throughout the world (BUZZEL, QUELCH and BARTLETT, 2002). In the same vein, Lindon et al. (2000) states that managers of organizations that internationalize should “develop skills that allow them to foresee future evolutions of the international market and take measures that will allow the company to adapt, which requires them to have great technical competence and great general culture”. That way, the successful Brazilian franchise brands in the international market emerge.

### **3. Brazilian Franchise Brands in the International Market**

The markets globalization is at the root of the increasing internationalization of franchises. It has created new opportunities for companies in international markets. The lower financial risk characteristic of its system, the advances in telecommunications technologies, which facilitate the control process, the benefits arising from the scale economies of a network and the flexibility of a small business, in addition with the knowledge about the local market provided by the franchisee, are some of the factors that drive the internationalization of franchises (SASHI and KARUPPUR, 2002).

Regardless of the type of franchise, like any organization, communication and information flow are vital factor for its survival, since “human organizations are information systems, as well as energy systems, and that every organization needs to absorb and use information” (KATZ; KAHN, 1975, p.256). Communication is, therefore, the very essence of an organization’s social system, because the support received by several of its publics is directly linked to the information received – especially when it comes to the company’s goals, activities and achievements. One of the great challenges in brand building is precisely in making the consumer associate, directly and immediately, a symbol or activity to the brand name.

It is very important to be able to differentiate a brand from the competition, since it identifies the origin of a product or service, that is, the perception that one has of a certain brand is what leads the company to work on its perceived image. It is important then to better understand the mechanisms of brand image for the competitiveness of this new type of organizational configuration (HOOLEY and SAUNDERS, 2001). For Porter (1986), competitive advantage is created through attractive prices or product differentiation. Hooley and Saunders (2001), on the other hand, consider that one of the ways to obtain differentiation is the relative quality perceived by the customer in relation to the product or service offered. This is what will provide greater impact on the return on investments in the medium and long term. Another form of differentiation is the favorable reputation of a brand, which can serve as an indicator of provenance and a guarantee of what can be expected from the product or service in question.

The brand is also a competitive advantage when it is registered, since it cannot be legally copied.

Competitive advantage can also be created through communication, when tools are used efficiently to build a positive reputation. Brand positioning, used as a communication differential, establishes a strong place in consumers' minds, as cited by Ries and Trout (1999), and involves emotional aspects linked to products and services.

The importance of a strong brand is one of the guarantees for starting a successful franchise. For most successful companies, the brand represents a value greater than its capital. According to Plá (2001, p. 41), "great brands emerge only after much effort, commitment and investments, and recognition is achieved only by companies that manage to maintain their positioning". Still in these authors perspective, entrepreneurs must be prepared to face the foreign market. And to be successful, it is necessary to do a lot of market research, a careful choice of the franchisee and the ability to pass on their competitive advantages to the target market. The success cases usually happen when franchisee and franchisor enter into a partnership in this new market.

In the case of the franchisee, the advantage would be the lower risks involved in opening the business, since he is opening a franchise with an already consolidated brand, some recognition and the franchisor's experience passed on to his business. The disadvantages are the costs that every franchise generates to the franchisee. And, besides this factor, there are situations in which many Brazilian franchisors go abroad with a low degree professionalism, without much criterion in the selection of partners, just reacting to unexpected opportunities. This highlights the need to adopt a strategic behavior, establishing organizational structures and adequate business models (ROCHA, 2002).

In addition, the brand is an essential part of the franchise system because it represents a significant advantage offered to potential franchisees: the appeal the brand exerts. However, effective brand management presents a major challenge for franchisors, as far as the responsibility for developing and managing a successful brand is shared by all parties involved in the franchise agreement, with no party having complete control of the brand management process. This co-dependence suggests that the success of the branding activities must be well coordinated and integrated, with well-defined and supervised responsibilities between the parties. In the view of many franchisees, the organization should be concerned not only with activities such as pricing and positioning, among others, but also with tactical brand management activities that are capable of sustaining the brand value in the long term (PITT, NAPOLI and VAN DER MERWEE, 2003).

There is also a preference for countries with a similar culture to Brazil (KHAUAJA, 2012). The main difficulties pointed out by internationalized Brazilian franchises are lack of knowledge of foreign markets, cultural differences, operational and legal difficulties and mainly the selection of suitable local franchisees. Another important factor is the lack of interest in expanding abroad when there is still a vast domestic market to conquer (KHAUAJA, 2012).

An investigation of the motivations for the internationalization of Brazilian franchises revealed the predominance of behavioral motivations, such as strengthening the company's image, knowledge about the international market and expansionist objectives. Economic factors also appeared: market niches abroad, the size of the market, the income of the population in the target country, scale economies, low operating costs in the international market, the support of governmental or sectorial agencies, the existence of Brazilian consumers in the foreign country, competitive advantage over international competitors and



geographical proximity to the destination country (MARQUES et al., 2005).

The franchise system will export not only the product, but mainly the brand. The consumer understands that the company that takes care of the brand works to better serve the customer and his needs; hence the importance of exporting the brand so that a company becomes internationally known. Pamplona (1999) defines well the importance of the brand for franchising: “the brand is a variable of utmost importance for the franchising system, it is the great driver of marketing strategies adopted by companies”. Through a good projection of their brands, companies can develop by adopting the franchising system. Therefore, it is important that the franchisor, when intending to enter a foreign market, be aware of the legislation and trademark registration, as Vazquez (2007) points out. As soon as the company intends to operate in foreign trade, it is important that the exporter seeks a specialized consulting service (trademark registration) so that it can be guided on how to act, protecting itself from the inconveniences that may arise from the unfair practice (VAZQUEZ, 2007).

The franchisee can develop his activity having the backing of a brand recognized nationally and internationally. It is essential that he trusts the experience of the company that owns the brand in being a franchisor. This confidence allows the business to attract customers who are already familiar to the products and services and recognize the brand because of this. For Silveira (2010, p.45), “the brand is much more than a logo, it means all forms of manifestations that impact the consumer market. It includes the tangible and intangible assets owned by the franchisor”.

Troiano (2009) completes yet, the importance of the brand to the consumer, because for him, “the best way to conquer your consumers and make them loyal to your brand is to start understanding who they are, what their needs and dreams are”, that is, entering their lives. The brand will always be well remembered by its customers as long as the company has this vision expressed in its product and service.

Analyzing the existing factors, one realizes that domestic marketing and especially international marketing act in progressive changes that need to be absorbed and understood quickly by professional in the field. About these aspects, according to Minervini (2001), “international marketing assumes the responsibility of elaborating the internationalization process that the company will adopt, essentially when it uses the franchising system for internationalization”, which is more complex; however, the company will enter with a system that is already standardized into a market that was unknown until then.

Operating in the international market exposes the company to contact with the most diverse types of customers, in general, with higher levels of demand and disputed by a large number of competitors, which favors learning processes and increases the capacity to adjust to changes in consumption patterns. In this way, different from what is indicated by the conventional interpretation, which considers the realization of exports as an indicator of competitive performance, foreign sales can be an important factor to stimulate competitiveness (MURPHY, 2006, p.46). Thus, it is essential that the brand be well and positively propagated in the international market to achieve success and stability.

## **4. Conclusion**

It is concluded that for the brand internationalization process to be successful, the company must adopt a correct international market entry strategy, because this is considered an important step that can leverage

the company in the future. It was observed that internationalization is seen as a form of continuous learning in the face of the competitions that exist in the international arena, something that involves time and risk. It is a way of introducing new actions, thus increasing the company's involvement with the foreign market. And with experience, costs are reduced, there is a reduction in uncertainties and profitability is greater.

It was observed that the main barriers to internationalization for national franchised brands are organizational, such as the difficulties of operating abroad and the lack of knowledge about foreign markets, showing that companies do not consider themselves prepared to operate outside their national borders. Also important are barriers related to investment capacity, such as the time required to recover expenses.

It was also noted that for the adequacy of the brand in the entry market, it is necessary to ensure the internationalization process, define a competitive strategy for entering the foreign market and plan the opportunities and threats of internationalization, which are considered indispensable strategies for companies that aim to conquer the foreign market. Another essential factor for success is the marketing strategy, which prevents the company from becoming outdated in the market where it operates, as well as through analysis, evaluation, adaptation and activation, which are tools that improve the interaction of marketing with the environment to which it belongs.

It is noteworthy that, with the advent of globalization, there was an ease in the consumption and sale of products, reducing the commercial boundaries between countries. Therefore, a very important aspect that must be considered when approaching any country is the culture, so if the products and companies adapt to cultural diversities, they can meet and create a market that did not exist before.

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# **Hybrid Instruction: A Study into Usage of Lecture and Student-Centered Learning During Class Time**

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## **Abstract**

*With declining confidence in higher education, it is timely to consider the optimization of students' class time experience. This study argues that class time should be devoted to development of student innovative skill. The authors' direct experience is blended with theory and findings from existing research to propose an innovative approach that, rather than being mutually exclusive, indicates the complementarity of lecture and student-centered pedagogies. In this hybrid format lectures provide the delivery of old and new knowledge, while the student-centered approach provides application of that information through class discussion and short, in-class assignments. The environment motivating this research is mainland China, with English Language Learner (ELL) Chinese students, with the study's aim being their cognitive, intellectual and second language development. The objective of this hybrid approach is the development of enhanced 'value add' to students' education, with a companion aim in the maintenance of tertiary institution and teaching relevance.*

**Keywords:** lecture, student-centered, engagement, short assessment, blended instruction

## **Introduction**

Higher education is at a crossroads. There is declining public confidence in inter alia the United States and Australia in higher education.<sup>i</sup> Ninety-one percent of those polled in the U.S. state that students who attend higher education institutions should make more than high school graduates, and 83% state that these jobs should enable them to pay off their loans.<sup>ii</sup> Three quarters of University trustees are concerned about the future of higher education,<sup>iii</sup> and cite student debt, tuition costs, and job prospects as top concerns of the

public.<sup>iv</sup> In Australia, while 78.8% have a high level of confidence in universities, only 60% ‘agreed or strongly agreed that universities were teaching students the important things they need to know.’<sup>v</sup>

Declining public confidence and the concern of university leadership establish the need for innovation in education. To meet these stakeholder concerns this paper proposes a hybrid instructional form that both conveys knowledge and develops skills demanded in the workforce. This can be done through blending lecture and student-centered instructional concepts during class time. Passive inputs through course knowledge are imparted to the student through lecture, and active inputs through class discussion and brief, in-class assignments are practiced through student-centered engagement. Use of different instructional forms and innovation in these assignments can instill in students an array of skills needed for professional and managerial roles in the workforce.

With increased attention given toward the student-centered teaching model,<sup>vi</sup> it is reasonable to assume that Western universities and their global joint ventures have increasingly embraced the ‘student-centered’ model of teaching. This model is defined as ‘an approach to learning in which learners choose not only what to study but also how and why,’<sup>vii</sup> and contrasted<sup>viii</sup> to the lecture model in five key areas: the balance of power in the class room between student and teacher, the function of course content, the role of the instructor relative to the role of the student, the responsibility for learning, and purpose and processes of evaluation. The choice of learning environment is important, as the learning environment is a strong predictor of student attitudes<sup>ix</sup> toward the subject matter and their learning outcomes.<sup>x</sup> This is for good reason, as the promotion of learning through student engagement positively affects student self-efficacy beliefs,<sup>xi</sup> which has a positive effect on student performance.<sup>xii</sup>

However, the place of content alongside the student-centered teaching model should be considered. For example, is it open to ask if a student can learn any subject without explanation of relevant concepts? Lecture and student-centered learning are not mutually exclusive but are complements, and of the five areas of contrast between the two models this paper defines the instructor as both a purveyor of knowledge and facilitator of intellectual development, thereby emphasizing the dual responsibility of the instructor and student.

An understanding of course content can be accomplished through a lecture-style format, led by the instructor, and application of that content can be accomplished through active, student-centered engagement, guided by the instructor but ultimately led by the student. While contemporary research frames the debate as a choice between active, student-centered engagement and the traditional lecture,<sup>xiii</sup> this paper proposes using both during class time. Content delivery and explanation of the content by the instructor is necessary for student understanding of the material, providing a scaffolding that allows students to apply their understanding to multi-faceted, real-world problems.



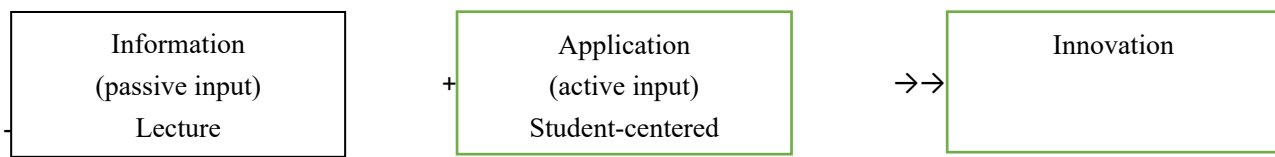
**Figure 1**

Figure 1: Passive input in absorption of information and active input in student-centered application

In each class give students opportunities to develop innovative skill, which is critical for leadership upon graduation.

### ***Why a hybrid model?***

A student's education should be a personal endeavor, as the student takes initiative, for example, to ask for feedback after in-class assignments are graded. In the classroom, however, student initiative should be encouraged by the instructor, with 'the curriculum...designed around students to motivate them and recognize their prior knowledge, skills, attitudes, and values.'<sup>xiv</sup>

Both lectures and class discussion-based methods are important because innovation through usage of information by the student must be both modeled and applied. For English Language Learners (ELLs), it is highly recommended that literacy skills of reading and writing be taught in an integrated manner.<sup>xv</sup> Lectures provide students the opportunity to listen to an expert convey knowledge, information and ideas efficiently,<sup>xvi</sup> and model the logic of the concept. However, real-world learning involves both passive and active input.<sup>xvii</sup> In the education context passive input comes from a balance of information received from the lecture, while active input comes through class discussion and in-class assignments where students analyze and generate information by themselves. From discussion students practice empiricism,<sup>xviii</sup> where information from lecture is augmented by their sensory experience,<sup>xix</sup> and shaped by their active engagement into course concepts. Patterned data shaped by sensory experience<sup>xx</sup> pass through limbic system brain structures that have 'a strong influence on the formation of memory.'<sup>xxi</sup> Through class discussion students are motivated to exhibit their acumen in front of their peers; in formulating quick answers they sharpen their critical thinking skills.<sup>xxii</sup> Learning comes with understanding, which is accomplished by giving the student the opportunity to think and reason.<sup>xxiii</sup>

### **Materials and Methods**

The following discussion describes a normal class session where both lecture and student-centered learning concepts are used. The class featured is a business law course taught in English in China, to 95 Chinese students. The course is designed to align with program objectives and learning goals defined in the course syllabus, and each class session is designed to develop the higher order thinking skills in Bloom's Taxonomy. Classes emphasize transparency in course information and expectations, and follow a simple, structured routine of announcements, lecture, student-centered discussion and in-class assignment. During lecture content from previous classes is recited, connection is made in the transition between previous classes and the current class, and new content is presented. Student-centered learning is achieved first

through class discussion between the instructor and student, and then through in-class assignments that are short, low-point, with questions that are open-ended and straightforward. Finally, the paper connects the skills developed during class to skills demanded in the workforce, considers work-load implications for faculty, and mentions future avenues for research.

## Results

Theory and findings of existing research support the use of this hybrid lecture/student centered model. The most important factor in student learning is the teacher. Instructor transparency in due dates, course requirements and rationale for an assignment creates a successful learning environment, and simple, structured routine both acclimates students to skills development within context and enhances student sensory experience within the classroom. Reciting old content improves long-term memory, and memorization of information enhances cognitive development, especially for ELLs. The transition from one set of content to the next improves brain activity, and ingrains language information in ELLs.<sup>xxiv</sup> The introduction of new information improves brain adaptability and note-taking of new information improves student learning, which is correlated with exam performance.

Student-centered, active learning encourages the student to ask questions, reflect, and ultimately find truth. Methods of instructor-student discussion such as the Socratic method, if utilized correctly, foster student creativity through experimenting with ideas, increasing difficulty in questions and topics raised, and assessment of thought. Learners at all levels improve their ability to innovate. Short, low point in-class assignments give students the incentive to take notes and review, take risks with answers, improve second language development and direct learning strategies, and for the instructor provides real-time insight into student learning gaps and with frequency of grades a consistent feedback between instructor and student. The different assignment types stimulate brain development and problem-solving skills.

## Discussion

### *Before Class – Implement hybrid model through course planning*

The class session must be planned, as innovation is an integrated process from beginning to end, as students pay attention to presentation of course information and new material, perceive connections to older material, process this information and make connections during class discussion, then apply the concepts during in-class assignments.<sup>xxv</sup> The structure of class, in every factor from note taking to use of the course material, aligns with course objectives and student learning outcomes. From the course syllabus, the pertinent course objectives are:

- Define or describe key concepts, specific facts, and critical issues of U.S. law, and correctly apply this information to examples;
- Use conceptual models and theories to analyze legal events and decisions;
- Apply legal science methods in making convincing arguments supported by evidence and reasoning.

Student learning outcomes are:

- 1) design a business idea and apply the principles of the course to that business
- 2) gain introductory knowledge into the impact of Chinese and Western history on law
- 3) understand the features and applicability of civil law and common law systems,
- 4) gain introductory understanding of the impact of constitutional law on commerce and business property,
- 5) choose the business form that best fits the business,
- 6) study and draft internal accounting principles based upon Chinese and Western accounting law,
- 7) understand legal principles of contracts and draft a contract for the business, and
- 8) analyze the advantages and disadvantages of doing business online, within the context of the law.

These program objectives and student learning outcomes require both implementation and application of knowledge according to the thinking skills identified in Bloom's Taxonomy.<sup>xxvi</sup> Classes proceed through each of these skills, as through the restatement<sup>xxvii</sup> of facts from previous classes students remember basic components. Understanding develops as students explain the ideas and concepts upon which these facts are based. Application occurs when, for example, students choose a business form. Analysis occurs when they compare the tax advantages of each business form. Evaluation occurs when they choose their business form, and after comparing the advantages and disadvantages explain why they chose their form. Creation occurs when they create the context upon which their analysis is based, create their business idea, and apply legal issues such as the employer-independent contractor distinction to factors they chose from the Internal Revenue Service (IRS) test.

With ELLs instructors should incorporate the principles of Second Language Acquisition<sup>xxviii</sup> into teaching strategies used and course design:

Principle 1: Ensure that learners develop both a rich repertoire of formulaic expressions and rule-based competence.

Principle 2: Ensure that ELL's focus predominantly on meaning

Principle 5: Consider the learner's built-in syllabus<sup>xxix</sup>

Principle 6: Utilize extensive second language input

Principle 7: Provide opportunities for output<sup>xxx</sup>

Principle 8: Provide opportunities to interact in the second language

Principle 9: Consider individual differences in learners.<sup>xxxi</sup>

### ***Strategy used to accomplish goals, objectives, and develop thinking skills: Transparency***

With the identification of goals, objectives, and the skills to be developed, the next question is how? Choice of strategy by the instructor is important, as it defines the steps and routines used by the instructor to help students obtain, store, retrieve, and use information.<sup>xxxii</sup> A clearly defined, daily routine from the instructor provides the student a consistent model on how to receive and use information, and from routine students act, behave, take steps toward, and through practice develop their skills to the context provided.<sup>xxxiii</sup>

A clearly defined, daily routine is accomplished through transparency by the instructor, which emphasizes honest communication, visibility and accessibility of information, with requirements and expectations clearly understood.<sup>xxxiv</sup> In teaching young adults it is important to explain to them why they are doing these assignments.<sup>xxxv</sup> Information, course expectations and course material are conveyed by the instructor through ‘carefully orchestrated visible and audible behaviors.’<sup>xxxvi</sup> Transparency includes not only what the instructor says or writes, but also the instructor’s body language, movement in the classroom, enthusiasm about the material, and eye contact, all of which are significant factors in conveying meaning.

The classroom atmosphere is based upon the teacher, as the most important factor affecting student learning is the teacher.<sup>xxxvii</sup> There is a positive relationship between quality of instructor and student achievement, as in classes of teachers classified as most effective students gain about 52 percentile points in their achievement over a year’s time, while students in classes of teachers classified as least effective gain about 14 percentile points over the same time.<sup>xxxviii</sup> Built through planning and transparency the classroom atmosphere prepares the English-only environment, and of crucial importance to students learning in a non-native language focuses their energies on engagement. Students reflect the atmosphere created by the teacher, and through transparency, respect, and mutual admiration the class takes on an orderly, problem-solving approach.<sup>xxxix</sup>

### ***First, the normal class day begins through simple, structured routine***

The class day begins. A consistent, simple, and structured routine is designed to utilize the student’s senses, as use of the sensory organs is the only way students understand and learn about the world outside themselves.<sup>xl</sup> Class opens with a simple greeting and smile from the instructor, who asks the students if they are having a good day. This lighthearted question engages the students, increases their comfort level, and prepares them for the English-speaking environment.

Next, the instructor reads announcements that are written on the blackboard. The use of multiple formats, such as students reading the announcements written on the board and listening to them repeated by the instructor, has a positive association with learning.<sup>xli</sup> Announcements set the stage, as for the remainder of class written text is structured, as PowerPoint slides and blackboard notes are written in outline form, with headings, subheadings, and their corresponding explanations. Explanations are given at a slow, methodical pace, giving students time to listen and reflect. This prevents confusion, and whether the student is learning in their second language or not it is necessary to remove as much confusion as possible.

### ***Second, content is presented***

#### ***Recapitulation of old content***

Students are now prepared for course content, and PowerPoint slides are displayed on the class projector. In setting a knowledge basis for lecture students recite information from the previous class. Memorization that comes from reciting old information gives the student the necessary information, that combined with new content later provides the opportunity to make connections and determine patterns across course topics. Frequent reference to information improves long-term memory, which allows the student to develop a deep

understanding of the material, and engage in more powerful analysis.<sup>xlii</sup> For the language learner memorization is a helpful strategy as it ‘provides the learner linguistic data,..., enhances association in memory, and causes cognitive development as a learning strategy.’<sup>xliii</sup> Questions are asked to the class in general and to specific students, which brings students into the content, as they are either interested in the subject or know they could possibly be called to answer.

#### *Transition from previous content to new content*

Transitions from previous<sup>xliv</sup> to new content include questions from the instructor which link the classes, so that students make connections and determine patterns in the information. Transitions reinforce the learning process, as ‘the practice of learning and applying information to new situations is a multifaceted process of making connections,’ as ‘applying conceptual understanding from one setting to the next requires students to utilize the brain’s capacity to build new neural networks.’<sup>xlv</sup> In answering these questions the student performs basic analysis and connects information.<sup>xlvi</sup> For example, in covering partnerships last class to covering corporations in the current class the instructor asks how each are taxed. This links both classes and piques students’ interest, as the students in the class are accounting majors. After this transition ELLs have read, listened, and possibly spoken in English, without any reliance on the students’ awareness that they have done this.<sup>xlvii</sup>

#### *New content*

Next, new content is displayed through PowerPoint slides. Content is simple and straightforward, designed to introduce a starting point for analysis, which the instructor explains in more detail. The introduction of new content is ‘compatible with the brain’s natural processes [as it] adapts and adjusts when it encounters new information.’<sup>xlviii</sup> Students take notes by listening to the instructor’s explanations and reading the instructor’s notes written on the board. Whether taking notes from lectures or from reading, note-taking and review of notes improves student learning,<sup>xlix</sup> and the quantity of notes is highly correlated with exam performance.<sup>1</sup> The use of electronic devices is banned, so students are encouraged to take notes using a writing utensil and paper. While laptop note takers record more verbatim notes and record more notes in general, those who write in longhand form study, organize, and elaborate upon ideas better.<sup>li</sup>

#### ***Third, student-centered learning begins through class discussion***

Now that content is delivered and explained student-centered learning begins through class discussion, where content is analyzed. Content was presented systematically and reinforced through reading, listening, and writing forms. Now, students take the information to answer questions of increasing difficulty under timed circumstances in front of their peers.

This method, the Socratic method, is a process in which the teacher guides the student to ask questions, reflect on information, and draw conclusions for the purpose of finding truth.<sup>lii</sup> It is a powerful tool that can be used to draw out student thoughts and analysis, but if used incorrectly discourages student input. The student and instructor are both responsible; while the student must actively listen, as they may be called upon, the instructor must be careful to both challenge the student and maintain their enthusiasm. If utilized

correctly the Socratic method generates thought and ‘fosters creativity through freedom of expression, experimentation, scaffolding of ideas, and reconstruction of thought.’<sup>liii</sup>

Take for example this dialogue on a class topic, business forms:

Instructor: “Student A, in choosing a business form which is one of the three factors we discussed?”

Student A: “Authority.”

I: “Why do you mention this factor?”

A: “Because I want to be in control.”

I: “So, this is the most important factor to you?”

A: “Yes.”

I: “More important than financing? Why?”

A: “Yes, because I believe that it is most important to be in control, and I do believe I can find the money through personal financing or a loan.”

I: “So, you want to be in control? Full control? If so, which form is best for you?”

A: “Yes, and sole proprietorship is best.”

I: “What is the responsibility of the sole proprietor if he goes bankrupt?”

A: Unlimited liability.

I: What do you mean? What assets could be taken?

A: His personal and business assets.

I: Which personal assets?

A: His home, car, anything he has.

This dialogue is structured so that students develop a greater understanding of the material through critical thinking. They take a simple position, consider multiple issues, explain their reasoning, weigh the importance of those factors, and either reaffirm or change their position. The practice of critical thinking is modeled, as the instructor integrates new and old content, has students recite simple facts, and asks simple questions, gives feedback during the dialogue, and fades support<sup>liv</sup> as layers of complexity are added to the material covered.<sup>lv</sup> The student is asked which factor is most important in choosing a business form, why is their choice most important, and on this basis decides which business form is best. Next, the student is asked about other factors in the choice of business form,<sup>lvi</sup> being legal responsibility, tax consequences, and financing. Finally, the student is asked to weigh authority with responsibility. The dialogue ends with the implied question if the student is comfortable with the choice of sole proprietorship as the business form, even if it means taking unlimited liability.

The ability of the student to understand the material, apply it to multiple contexts, compare and contrast business forms (for example), weigh the factors, and design the answer determines their grade.<sup>lvii</sup> Movement from memorization and understanding to the higher-order thinking skills of application, comparison and contrast, weighing, and design are necessary in the development of all learners, as both high and low achieving students make significant gains in achievement<sup>lviii</sup> through development of these



skills. With the content foundation students have center stage, as they recite simple facts, give their opinion, and deal with layers of complexity that lead to a choice of business form.

#### ***Fourth, student-centered opportunity for innovation occurs through in-class assignments***

Students take these passive and active inputs to complete brief, in-class, short cycle assignments at the end of class.<sup>lix</sup> These are low point<sup>lx</sup> assignments that serve several purposes:

- First, given that there may be an in-class assignment students have the incentive to review their notes. Students take the notes longhand and review their notes from the current and previous classes. By reviewing and recording notes longhand students achieve more than laptop notetakers,<sup>lxi</sup> and helps the student improve listening, comprehension of the material, and retention of concepts.<sup>lxii</sup>
- Second, results from the university English proficiency exam for the incoming freshmen class show that compared to writing and speaking listening<sup>lxiii</sup> is by far the lowest-performing portion. To complete these assignments successfully, students must listen to the instructor and classmates and participate.
- Third, these students may take as many as nine courses in a semester, so having in-class assignments decreases their out of class workload. As stated, these assignments are low point, which relieves stress and gives the students opportunities to improve their grades.
- Fourth, in-class assignment grades are posted in installments,<sup>lxiv</sup> and the scores establish a benchmark of their performance. This process also establishes feedback and a continuous learning opportunity between instructor and student, where through tracking scores students and instructor assess their progress in writing, analysis, and understanding of the course concepts.<sup>lxv</sup> Feedback methods include giving extra credit for exceptional answers,<sup>lxvi</sup> praising students for their work,<sup>lxvii</sup> telling students why their answers are optimal or less than optimal,<sup>lxviii</sup> and giving suggestions on how they can improve.<sup>lxix</sup>
- Fifth, these assignments are short and faster to grade, which makes it easier for the instructor to identify student writing and analytical gaps throughout the semester, provides insight into how course content can be adjusted, and in possible research applications cultivate objective, verifiable data to assess student conceptual understanding and English proficiency.
- Sixth, critical thinking used in these in-class assignments builds second language development. Proficiency improves through development of analytical skill, which involves direct and indirect strategies<sup>lxx</sup> which the teacher can use to support second language development.
- Seventh, the student develops direct learning strategies, such as memory strategies, where student stores and retrieves new information, cognitive strategies applied by learners to better understand and produce the target language through summarizing and reasoning exercises, and compensatory strategies to address knowledge difficulties in the target language, such as identifying meaning from context.<sup>lxxi</sup>
- Eighth, the student develops indirect learning strategies, such as meta-cognitive strategies where students control their own cognition, affective strategies that emphasize motivation and self-encouragement, and social strategies that emphasize use of course knowledge in interacting with classmates.<sup>lxxii</sup>

***Assignment types, parameters and open-ended questions***

Changing assignment types, questions, time and concepts covered is vital to brain growth, as ‘an environment that has mostly predictable or repetitive stimuli fosters boredom in the brain, making it turn inward for new and novel stimuli.’<sup>lxxiii</sup> While students know the possible assignment types and possible content covered, they do not know the exact assignment type, question, completion time, or concept that will be assessed. Strong written and oral communication skills, especially within ever-changing and unpredictable circumstances, are recognized as necessary for success by employers, who view colleges and universities as responsible for their development.<sup>lxxiv</sup> The unpredictability of the assignment type and question asked encourages not only the retention of facts from lecture, but also meaningful learning in transfer of that knowledge to facilitate understanding of the new content and solve new problems.<sup>lxxv</sup> Students must complete these assignments within timed limits that, depending on the difficulty, range from 10-20 minutes.

Word limits are given, which imparts to students the importance of word choice. This makes grading more convenient, but in regulating their verbosity the student practices meta-cognition. The student looks at their work and decides how they can make their answer more concise. When students assess their own thought process, they gain confidence in their ability to learn,<sup>lxxvi</sup> and when they do so regularly through these assignments, they design strategies to communicate. Students learn that words are tools that can be used to express meaning to the listener or reader.

Questions are straightforward, with clear structure and vocabulary that are discussed in class and moderately push student proficiency. Examples of these assignments include:

- Explain jurisdiction in your own words.
- Summarize Monday’s class to your partner.
- In your opinion how can contracts reduce misinterpretations between the employer and worker?

These questions are short, simply worded and, as in the dialogue above, proceed to increasing levels of difficulty, and draw upon both old and new knowledge. Through the open-ended nature of the question the student reflects on the concept and how they will answer. Reflection draws upon the student’s thoughts about the concepts, and in review of the knowledge gives them a canvas to express their understanding. The student’s answer involves the two highest steps in Bloom’s Taxonomy; through evaluation the student selects the most important information to provide from lecture and class discussion, and through innovation crafts their best method to present the answer and content.

***In-class assignment types***

Different assignment types test different skills and promote brain development, as ‘the brain requires stimulation, novelty, and problem-solving opportunities.’<sup>lxxvii</sup>

- Through summaries students state the main ideas of the material in their own words. It is objective in tone, meaning the student does not include any of their own opinions or analysis into the work.<sup>lxxviii</sup>

- Multiple choice questions help students recall course content,<sup>lxxix</sup> and test a student's analytical ability, use of their notes and PowerPoint slides, and attentiveness in class.
- Notetaking assignments test student comprehension skills and ability to identify important ideas. Students divide into teams; while one student gives a verbal summary of the course material, the other student listens, takes notes, explains which subjects their partner missed, and describes the importance of the missed concepts. Then they switch roles. Giving students the opportunity to work together allows them to exchange ideas, answer questions, and teach each other.<sup>lxxx</sup>
- A distilled version of the Socratic process through short answer questions: student answers a simple question based on the course material, explains why they chose that answer, any trade-offs in making that choice, and based upon that answer and their preferences draws a conclusion.

## Conclusions

Within the context of an 'evolving socio-economic environment' the European Commission for Education and Training states that people must be equipped with a set of literacy, numeracy, and digital competencies. 'Critical thinking, creativity, and ability to work as a team are equally important to build sustainable careers and become active citizens.'<sup>lxxxi</sup> In a 2018 global study employers identified problem solving, teamwork, communication, adaptability, and interpersonal skills as the most important workplace skills.<sup>lxxxii</sup>

Innovation is the desired product of this proposed model because it builds within the student leadership skills demanded of professionals and managers. Leadership comes from a strong set of beliefs grounded in knowledge, and a vision designed from this knowledge and beliefs.<sup>lxxxiii</sup> The hybrid model encourages leadership grounded in knowledge and a self-created vision, as lecture provides the passive inputs needed to supply students that knowledge, and class discussion and in-class assignments provide the active inputs students need to create answers and direction. This approach is consistent with employer demands of professionals, as students analyze situations, conduct research, develop concepts, theories and methods, and apply existing knowledge to problem solving, skills demanded of professionals.<sup>lxxxiv</sup> For managers, employers 'plan, direct, coordinate, and evaluate the overall activities of enterprises..., and formulate...their policies, laws, rules, and regulations.'<sup>lxxxv</sup>

Are college programs developing these skills needed by employers? College boards and presidents are aware<sup>lxxxvi</sup> that public confidence in United States higher education has declined since 2015,<sup>lxxxvii</sup> and that families will scrutinize future options for their children. Innovative instructional forms and skills-based development should be embraced, and the effectiveness of each assessed, as community colleges and four-year universities must compete with vocational and technical schools, the workforce, and each other for student enrollment.

One implication of the hybrid format is the labor-intensive aspects in preparing weekly slides, questions to guide class discussion, in-class assignments and grading of those assignments, and altering course content and assignments according to student performance and needs. Dissatisfaction with workload is common

among faculty as an ‘unrelenting pressure to perform.’<sup>lxxxviii</sup> Often faculty have the impression that they must excel in teaching, research and service, demands that 52% of associate professors say that they are unable to balance.<sup>lxxxix</sup> With each new initiative and innovative idea the continuous message sent is ‘[academic] do more.’ A clear indication implicit in this concern is that the proposed approach cannot have labor intensification as an implication.

While there is evidence that people differ in how they think and process information, there is no evidence to indicate that students maximize their performance when provided their preferred method of learning.<sup>xc</sup> Instead of viewing one style as superior to another, each style itself should be analyzed for the skills it develops. Diversity of instructional styles should be encouraged, as it provides students a wider array of skills. New and old ideas can coexist.

Further research is needed to determine those skills developed through use of and interaction between different pedagogies. Research can have a defined focus in evaluating aspects in the relationship between student and staff, student perceptions of these relationships, the use of staff to investigate and utilize research-based education practices, connecting student activities with real-world outputs and the workplace, and the place of peer learning.<sup>xcii</sup> Simply, the presumptive superiority of one style as effective, as opposed to the reflective consideration of the advantages and disadvantages of individual teaching approaches, risks ‘throwing the baby out with the bathwater’ and marginalizing tertiary education.

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\_\_\_\_\_

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# Noncognitive Factors Affecting Academic Achievement of Juvenile Delinquents

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## Abstract

*The present study provides a description and analysis of the plight of first-time detained juvenile delinquents in the United States and the impact of noncognitive attributes and academic achievement on grades. Juvenile delinquents have poor outcomes as adults in higher rates of drug abuse, poor high school graduation rates, and lowered employment well into adulthood. The research questions examined the correlation among the noncognitive attributes of grit, academic self-concept, mental health, and self-esteem, academic achievement, and English and Mathematics grades for first-time detained juvenile delinquents aged 10-18. A multiple regression analysis of archival records of students in a short-term juvenile detention center was conducted. Findings showed three predictor variables were statistically significant and influenced academic performance measured by grades: verbal ability, social self-esteem, and prosocial skills. For juvenile delinquents ( $n = 72$ ; males = 58, females = 14) aged 10-18 ( $M = 15.3$ ;  $SD = 1.6$ ; range 10-18), the three predictor variables predicted English grades (adjusted  $R^2 = .280$ ) and Mathematics grades (adjusted  $R^2 = .225$ ). There was a discussion and recommendations for policies and research. The results support the need to consider noncognitive factors and the consideration of communication skills in the education of juvenile delinquents.*

**Keywords:** juvenile delinquency, noncognitive, alternative education, multiple regression

## 1. Introduction

While juvenile delinquents typically have lower reading and math skills than nondelinquent peers, there has also been an interest in juvenile delinquency and noncognitive factors, such as self concept, for over 50 years (Brookover, Thomas, & Paterson, 1964; Lund & Salary, 1980; Zinkus & Gottlieb, 1978). Juvenile detention centers often provide substandard educational services to delinquents and fail to provide appropriate services for students with disabilities. (Leone & Meisel, 1997; Leone & Wruble, 2015; Twomey, 2008). Juvenile delinquents suffer from mental illness and substance abuse at a much higher rate than similarly situated peers, and most problems persist well into adulthood (Denzel, van Esch, Harte, & Scherder, 2016; Fazel, Doll, & Långström, 2008; Lea & Abrams, 2017; Quinn, Rutherford, Leone, Osher, & Poirier, 2005; Welty et al., 2016).

Involvement in the juvenile justice system has been found to better predict dropping out of high school than demographic factors, school attendance, and socioeconomic status (Robison, Jagers, Rhodes, Blackmon, & Church, 2017). Education in juvenile detention lacks a strong foundation, with unprepared

teachers, poor leadership, absence of adequate resources, and few research-based intervention (Baetz et al., 2019; Flores & Barahona-Lopez, 2020; Gabel, 2016). In spite of the long history and research, direct research in correctional education lacks systematic, quality research existed among the participants in the juvenile justice system (Davis et al., 2014; Erofeeva et al., 2019; Mathur & Schoenfeld, 2010).

The gap is most acute among first-time detained juvenile delinquents. A review of the top three policy journals, *Educational Policy Analysis Archives*, *Educational Evaluation and Policy Analysis*, and *Journal of Education Policy*, as well as a search in Google Scholar, EBSCO, and ERIC, found no comparable research for policies concerning first-time detained juvenile delinquents. For example, the book *Making it Count: Strategies for Improving Mathematics Instruction for Students in Short-term Facilities* (Leone, Fink, Wilson, & Mulcahy, 2018) provided no direct research from short-term facilities in the book, as there was little research in short-term facilities because of availability and high transient rate (Babel et al., 2016; Sedlak & Bruce, 2016). Analyzing the National Longitudinal Survey of Youth 1997, juveniles involved in delinquency and incarceration had reduced high school and college graduation rates (Ward & Williams, 2015). Since first-time detained juvenile delinquents are at risk for future failure in school and life, understanding causes of educational failure could improve graduation rates and reintegration back into society.

Though juvenile delinquents face many challenges, research findings suggested two-thirds wanted to go to college, with positive expectations about future educational achievement and avoidance of criminal activity (Mahler, Fine, Frick, Steinberg, & Cauffman, 2017; Sedlak & Bruce, 2016). The problem is the correlation of noncognitive factors of grit, academic self-concept, mental health, and self-esteem and academic achievement on grades for first-time detained juvenile delinquents aged 10-18 was not known. The results could be used to improve instructional practices in juvenile correctional facilities and reduce recidivism. The following study provides a review of the literature. A description of the sample and methodology follows. There is an interpretation and discussion of results, with policy recommendations.

## 2. Literature Review

Most juvenile delinquents have a long history of problem behavior entering the criminal justice system, and first-time juveniles incarcerated have a much higher prevalence of mental illness and aggression (Barrett & Katsiyannis, 2017). Juvenile correctional facilities have a poor track record in successfully educating juvenile delinquents, with Suitts (2014) having found “most juvenile justice schools have had little positive, enduring impact on the educational achievement of most children and youth in state custody” (p. 15). The literature review examines four components of juvenile delinquency: a theory of juvenile delinquency, academic characteristics, problems, and the gap in the literature.

Social learning theory described the intersection of learners directing one’s own efforts toward outside goals, with students being proactive versus reactive to the educational experience (Rendell et al., 2011; Zimmerman, 2013). A review of research and found social learning theory explained crime and deviancy better than other theories because differential association and imitation produced conforming behavior (Jensen, 2017; Winfree, 2015). Associational preferences, a central aspect of social learning before and after incarceration, included juvenile delinquents having a referent group with much higher rates

of antisocial behavior and psychopathology (Lopes et al., 2012; Pratt et al., 2010; Tatar, Joseph, Cavanagh, & Cauffman, 2016). Applied to incarcerated juvenile delinquents' schooling, social learning theory supported the exploration of expected academic achievement and actual performance as viewed from the internal struggles juveniles faced (Engel, 2017; Herrman & Sexton, 2017).

Juvenile delinquents as a group possessed IQs in the low-average to below-average range, and a history of academic and school failure existed, with attention deficit commonly found (Falligant, Alexander, & Burkhart, 2017; Foley, 2001; Hoffmann, 2020). Incarcerated juveniles, scored, on average, a standard deviation below peers on standardized academic achievement, and a prevalence of disabilities and psychiatric illnesses defined the population (Krezmien, Mulcahy, & Leone, 2008; Vaughn, Salas-Wright, DeLisi, Maynard, & Boutwell, 2015). Juvenile detention center schools have a different population than regular school, with about one third diagnosed disabled, and behavioral and emotional diagnoses better predicted academic achievement than grades (Engstrom & Scott, 2020; Ennis, Evanovich, Losinski, Jolivet, & Kimball-Greb, 2018; Quinn, Rutherford, & Leone, 2001). Adolescents with rapid cognitive tempo, conduct disorders, substance abuse problems, poor inhibition, and high impulsivity were incarcerated at a higher rate (Beaudry, Yu, Långström, & Seena Fazel, 2020; Carroll et al., 2006; Ray, Thornton, Frick, Steinberg, & Cauffman, 2016).

Juvenile delinquents had a myriad of other problems beyond academic and behavioral issues in school. Developmental delays were common and caused problems with desistance after detention (Crosby, Algood, Sayles, & Cubbage, 2017). Self-views, important in determining academic and social outcomes for juvenile delinquents, were generally negative, and the appraisal of peers influenced one's self-view (Kõiv, 2016; Walters, 2016). Behavioral and emotional dysregulation were the norm in juvenile delinquents, and the youths in juvenile detention scored low on emotional intelligence in peer relations (Mohanty & Nanda, 2018). Juvenile delinquents with mental illness often do not get the therapy needed, with one study finding 95% of juvenile offenders with major mental illness diagnoses failed to receive evidence-based treatments (McCart & Sheidow, 2016). When students self-regulated behavior and developed accurate cognitive appraisals, juveniles displayed better mental and physical health (Gardner, Dishion, & Connell, 2008; Raftery-Helmer & Grolnick, 2018; Reynolds & Crea, 2015; Trzesniewski et al., 2006).

When socioeconomic status was factored into student achievement, intrinsic motivation, school engagement, and length of education suggested improved educational practices have been shown to improve academic achievement (Froiland & Oros, 2014; Losel & Bliesener, 1994; Ritchie & Bates, 2013). The research has not bridged the gap between theory and practice; juvenile delinquents after release continued to struggle in school after incarceration (Rice, Musil, Kretschmar, & Warner, 2018). After instituting a myriad of programs, interventions, and time spent trying to improve the lives of juvenile delinquents, the dropout rate remained dismal, and the chances for early death were much greater (Aalsma et al., 2016; Feinstein et al., 1998; Sampson & Laub, 2003). Approximately 100,000 juveniles were released from detention each year, but only 50% returned to school and about 16% dropping out within five months (Benner, Zeng, Armstrong, Anderson, & Carpenter, 2016). For most juvenile delinquents, placement in a juvenile detention center worsened the situation and increased deviancy, with peer-led interventions often harmful (Asencio & Burke, 2011; Cullen & Jonson, 2014; Dishion, McCord, & Poulin, 1999).



### 3. Method

To conduct the present study, permission from a regional juvenile detention center for archival records was secured. Institutional Review Board granted permission as long as personal descriptors were removed. After receiving permission, within two weeks, the facility's registrar removed personal and confidential information and transmitted the data. All Excel files were checked for missing or erroneous values, and within a week or two, all information was converted to a CSV file for use in JASP (Jeffreys's Amazing Statistics Program). Using JASP, the data were analyzed.

A multiple regression analysis of the correlation of noncognitive factors and academic achievement on English and Mathematics grades for first-time detained juvenile delinquents aged 10-18 was conducted. This study's research questions were based on a theoretical framework where juvenile delinquents received learned behavior from others, and adaptive leadership by practitioners could improve outcomes. The research questions and hypothesis are outlined, the sample and setting described, instrumentation utilized, data analysis conducted, and results interpreted.

#### 3.1 Research Questions and Hypotheses

Backward regression analysis and correlation showed the relationship of variables. For predictor variables, mental health (overall, emotional, conduct, hyperactivity, peers, and prosocial), academic self-concept (Math and English), academic achievement (math, verbal, math computation, math application, reading comprehension, vocabulary, and language mechanics), grit, and self-esteem were examined for correlation and, or regression to the criterion variables of grades in mathematics and language arts after three weeks. The purpose of the research was to see if cognitive and noncognitive variables impacted student learning and grades. The following research questions and hypotheses guided this study:

**Research Question 1:** What is the degree of correlation between noncognitive attributes and academic achievement on grades in English for students first detained in juvenile detention facilities?

*H1<sub>0</sub>:* There is no statistically significant correlation between noncognitive attributes and academic achievement and English grades.

*H1<sub>A</sub>:* There is a statistically significant correlation between noncognitive attributes and academic achievement and English grades.

**Research Question 2:** What is the degree of correlation between noncognitive attributes and academic achievement on grades in Mathematics for students first detained in juvenile detention facilities?

*H2<sub>0</sub>:* There is no statistically significant correlation between noncognitive attributes and academic achievement and math grades.

*H2<sub>A</sub>:* There is a statistically significant correlation between noncognitive attributes and academic achievement and math grades.

#### 3.2 Data Analysis

This nonexperimental, ex post facto quantitative study sought to determine if the independent (predictor) variables of noncognitive attributes (academic self-concept, mental health, grit, and self-esteem) and academic achievement (standardized testing in math and verbal) related to the dependent (criterion)

variable of academic outcomes measured by students' grades in English and mathematics for first-time-incarcerated juveniles. Multiple regression analysis uses predictor variables to describe the variance or relationship with a criterion variable. Backward multiple regression was used after meeting all assumptions, which allowed the construction of a model for the best fit (Garson, 2014). The results may be useful to improve educational programming for juvenile delinquents. Correlation and multiple regression analysis were used to ascertain the relationship, if any, of many independent variables with a single dependent variable (Creswell, 2012).

### **3.3 Sample Selection and Setting**

The sampling strategy used was convenience sampling, which was affordable, easy, and used subjects readily available. Convenience sampling operates under the assumption the population would not be different from the sample (Etikan, Musa, & Alkassim, 2016). The participants were from a regional juvenile detention center in a small town in central Illinois which housed up to 26 juveniles, and the sample's demographic data by age, sex, race, school status, grade, and special education status were collected. All records were archival, so there was no direct participation, and all students left by the time data were collected. Most students had short-term detainments in juvenile detention center. To be included, students were first-time-detained juvenile delinquents, enrolled long enough to earn grades, and completed all survey instruments within five school days upon entering school (generally all noncognitive tests and the Test of Silent Contextual Reading Fluency-2 (TOSCRF-2) were given on the second school day, and the Basic Achievement Skills Inventory-Survey (BASI-S) was given on the fourth school day). Initial intake by juvenile officers screened juveniles to determine if enrollment was the first time in secure detainment.

The setting was a short-term regional juvenile detention center in a small midwestern town in central Illinois. The school had two full-time teachers and two substitutes. School was in session 257 days per year and operated off a modified block schedule (four core subjects, physical education, two electives by computer-guided instruction, response to intervention as needed, and remediation on tablets). The average stay at the juvenile detention center was 30.5 days, with a range of one to 250 days. Up to 26 students can be housed at once, though sometimes the facility was at overcapacity. The students were required to attend school, though many were only enrolled for a short time before either going home, state correctional facilities, or residential treatment. Though the detention center was in an urbanized area, the population came from an 11-county area and ranged from rural to urban. In a given year, approximately 160–250 students passed through the juvenile detention center, and recidivism was high (approximately 25% or more of the population were repeat offenders). Many of the students stayed less than a week or got released the next day.

### **3.4 Instrumentation**

The instruments were all standardized across many ages and provided insight into a student's academic, social, and emotional status. Intake procedures required juveniles complete all instruments within five school days of entering school. Teachers administered all tests. Predictor variables were measured by State Self-Esteem Scale (SSES) included a total score and subscales of performance, social,

and appearance, Marsh's Math and English Academic Self-concept, BASI-Survey (including subscores of math computation, math application, vocabulary, language mechanics, and reading comprehension), TOSCRF-2, Grit-Short Scale, and the Strengths and Difficulties Scale SDQ (included a total and subscales of emotional, conduct, hyperactivity, peer, and prosocial). Concerning the criterion variables, grades obtained after three weeks in English and math were used to be as close to the noncognitive assessments administration and because the facility studied was a short-term facility.

Correlational data analysis and multiple regression analysis require selection of variables of appropriate controls (e.g., age, gender, race), and selection was guided by controls used in published research (Creswell, 2012; Dattalo, 2013). All instruments had adequate validity and reliability. The following instruments were used to measure noncognitive and cognitive variables:

**State Self-Esteem Scale.** The work of Heatherton and Polivy (1991) developed the 20-question SSES to measure three correlated factors (performance, social, and appearance), and the SSES provided a global score of self-esteem. In use with adolescents, the SSES demonstrated adequate validity and reliability (Linton & Richard, 1996). High scores mean high self-esteem.

**Academic Self-Concept.** Following the Marsh/Shavelson model, subject-specific models for language arts and mathematics were developed and analyzed, suggesting each scale measured single subjects versus broad generalities. The Language Arts and Mathematics Academic Self-Concept (ASC) Scales both have adequate internal reliability (Marsh, 1990). Each survey is four questions and measures academic self-concept in language arts or mathematics. High scores mean a high academic self-concept.

**Grit-Short Scale.** The eight questions Grit-Short Scale was found to possess adequate predictive power, and the instrument was shown to be psychometrically sound (Duckworth & Quinn, 2009). The survey assesses grittiness of a student, with the higher the average, the higher one's grit. Scores are averaged, and a higher score means higher grittiness.

**Strengths and Difficulties Questionnaire.** The 20-question SDQ was developed as a brief screener for ages 4–18 to identify mental health problems in students concerning adjustment and psychopathology (Arman, Amel, & Maracy, 2013). The SDQ was shown to be psychometrically sound (Bourdon, Goodman, Rae, Simpson, & Koretz, 2005; Goodman, 2001). The survey has the subscales of emotional, conduct, hyperactivity, peer, and prosocial. The prosocial scale is a separate component and does not contribute to the omnibus score of the SDQ. Other advantages were the SDQ listed strengths as well as difficulties and gave coverage to peer relations and prosocial behavior (Goodman, 1997). A higher score means there either borderline or abnormal.

**Test of Silent Contextual Reading Fluency-2.** The TOSCRF-2 has adequate reliability and correlated to the Woodcock-Johnson (Dumont, Willis, Veizel, & Zibulsky, 2013). The TOSCRF-2 gives raw scores, standard scores, percentiles, and age and grade equivalents.

**Basic Achievement Skills Inventory-Survey (BASI-S).** The BASI-S provides math and verbal scores, and all sections and questions had adequate psychometric properties (Broxterman, Mok, & Beukema, 2017). The BASI-S has two major tests, math and reading (verbal), and five subscores (math computation, math applicability, vocabulary, language mechanics, and reading comprehension). Each test generates a number of scores: standardized scores, age range, grade range, subscores, percentiles, confidence intervals, and descriptors.

### 3.5 Data Analysis

A variety of non-cognitive and cognitive variables were used, as shown in Table 1. The noncognitive instruments measured self-esteem, grit, academic self-concept, and mental health. Academic ability was measured with two instruments: BASI-S and TOSCRF-2. While the TOSCRF-2 measured reading fluency, the BASI-S measured reading and mathematics ability, and the instrument provided a variety of subscores.

Table 1

*Predictor Variables*

Predictor variable	Instrument	Scale
Self-esteem; performance self-esteem; social self-esteem; appearance self-esteem	State Self-Esteem Scale (SSES) with three subscores and a total and Single-Item Self-Esteem Scale (SISE).	SSES has a 100-point scale, with Performance, Social, and Appearance are the subscores. SISE is a 7-point Likert scale
Grit	Grit–Short Scale	Students answer 8 questions on a 5-point scale.
Academic self-concept: math and English	Marsh’s Academic Self-Concept for Mathematics and English.	Students answer 4 questions on a 6-point scale for each question.
Mental health: emotional, conduct, hyperactivity, peer, prosocial, and total	Strengths and Difficulties Questionnaire.	Students answer 20 questions on a 3-point scale: not true, somewhat true, or certainly true.
Verbal	Basic Achievement Skills Inventory–Survey (BASI): Verbal	Standardized scores, age equivalency, and grade equivalency.
Verbal—Language mechanics	BASI: A subscore of Verbal measured with a standard score.	Scores range from 1 to 10
Verbal—Vocabulary	BASI: A subscore of Verbal measured with a standard score.	Scores range from 1 to 10
Verbal—Reading comprehension	BASI: A subscore of Verbal measured with a standard score.	Scores range from 1 to 10
Mathematics	BASI: Mathematics	Standardized scores, confidence intervals, age equivalency, and grade equivalency.

Mathematics—Computation	BASI: A subscore of Mathematics measured with a standard score for computation.	Scores range from 1 to 10
Mathematics—Application	BASI: A subscore of Mathematics measured with a standard score for application.	Scores range from 1 to 10
Reading fluency	Test of Silent Contextual Reading Fluency—2:	Standardized scores, confidence intervals, and grade equivalency.

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The demographic variables and noncognitive and academic variables from were regressed on the criterion variables of students' grades for language arts and mathematics after three weeks to develop a model. The grade scale was 6 = A, 5 = B, 4 = C, 3 = D, and <2.5 = F. Grades were assigned holistically; rather than percentages, as students received grades based on mastery of the activity assigned. The cutoff was three weeks, as the facility was a short-term facility, and students arrived and exited frequently.

Multiple regression analyzes correlation between two or more variables, and requires the following assumptions: reliability of measurement, normality, homoscedasticity, linearity, independence of errors, and multicollinearity (W. E. Martin & Bridgmon, 2012; Osborne & Waters, 2002). Plots can be used to find strong and weak correlations, and the largest sample possible was procured to obtain a valid effect size and for power considerations (Abbott & McKinney, 2013). Multiple regression analyses checked for relationships between noncognitive attributes, academic achievement, and grades in English and math at three weeks for first-time-detained juvenile delinquents. An ANOVA table provided information if the model was significant at the .05 level. A regression equation was developed. Soper's calculator for power analysis and G\*Power conducted post hoc tests. JASP tested all assumptions by plotting residual plots, Q-Q plots, and running tests for outliers, variance inflation factors (VIFs), and tolerance (Goss-Sampson, 2018). After checking for all assumptions, a power test checked for adequate sample size and possibility of a Type II error. Using regression and beta coefficients, as well as the coefficient of determination, the relationships were identified.

### 3.6 Results of Demographics

There were 72 students in the sample. The average age was 15.3 ( $SD = 1.6$ ; range 10–18), but 73.6% were between the ages of 15–17. Most students were male (male = 58; female = 14), as the facility was a coeducational juvenile detention center. Students were incarcerated for offenses which as adults would be a felony or misdemeanor. All students included in the study experienced problems in traditional school. Very few students were at either extremes of middle school or 18 and over. Younger students were relatively rare, with only 5.6% of students aged 10–12. Few students were in middle school compared to the overall population. Older high school students, at the ages 16 and older, predominated. Most students

had not earned enough credits to be counted as juniors or seniors, placing most students at risk of dropping out of high school.

A further breakdown of demographics was examined. Of the 72 students, 39 (54%) were Black, 2 (2.7%) were Hispanic, and 31 (46%) were White. Students self-reported race upon intake. There were slightly more Black students than White. The Hispanic population was very low. Though 50% of students were 16 years of age and over, the students as a collective were behind academically and at risk of school failure. There were 22 (30%) students 17 years of age, yet only 21% were in 11th and 12th grade. Students were over age compared to the students' grade level and lacked sufficient credits to be on track to graduate.

Special education was overrepresented, with 32% of students receiving services (seriously emotionally disturbed was most prevalent, comprising 18% of the total population). Special education was overrepresented, with 32% of students receiving services (seriously emotionally disturbed was most prevalent, comprising 18% of the total population). Students with special needs made up approximately one third of the facility, and most students were behind academically regardless of disability. Descriptive statistics revealed students, compared by grade level ( $M = 9.333$ ;  $SD = 1.703$ ), were more than one standard deviation behind in reading (BASI verbal GE  $M = 6.065$ ;  $SD = 2.446$ ) and math (BASI math GE  $M = 5.525$ ;  $SD = 2.404$ ).

### 3.7 Results of Instrumentation

Self-esteem was measured by the SSES. For the SSES, subscores of performance ( $M = 71.9$ ,  $SD = 15.849$ ), social ( $M = 71.5$ ,  $SD = 14.992$ ), and appearance ( $M = 71.6$ ,  $SD = 16.742$ ). All subscores of the SSES, performance, social, and appearance, were similar.

Mental health was screened by the SDQ ( $M = 14.4$ ,  $SD = 5.296$ ), with five subscores, which suggested over 42% of all juveniles needed further evaluation for psychiatric problems. The SDQ-E and SDQ-H suggested many students had difficulties with emotional regulation and hyperactivity. On the SDQ-PRO, the average and standard deviation suggested a quarter of the population were statistically different in a negative way.

Students' self-perceptions, concerning abilities and work ethic were measured with the Grit-Survey Scale, Math Academic Self-Concept, and English Academic Self-Concept. Grit-Survey revealed an average of 3.3 ( $SD = 0.68$ ). Percentiles suggested students had average to high average grit. Though students were delinquent and had long histories of school failure, students in juvenile detention reported resiliency in schoolwork. On the Math ASC students had an average of 14.1 ( $SD = 4.2$ ), and the Language Arts ASC had an average of 16.3 ( $SD = 5.0$ ). Students, on average, felt more confident in ability and aptitude in English than math. Percentiles suggested students viewed academic self-concept by subject differently.

Measures of academic achievement were conducted using BASI-S and TOSCRF-2. The standardized scores average was 85.7 ( $SD = 12.8$ ), which showed most students were between low average to average. The BASI age equivalency suggested students were average age of 11 ( $SD = 2.7$ ). All subscores were similar and toward the low average end of the scale. Salient factors were the BASI verbal scores ( $M = 85.6$ ;  $SD = 12.8$ ) matched closely with the TOSCRF-2 ( $M = 85.4$ ;  $SD = 11.7$ ). Students in math were further behind on the BASI math assessment, with a standardized score of 79.1 ( $SD = 11.7$ ) and age



equivalency of 10.7. Overall, students' skills were similar to upper elementary and lower middle school, though most students were in high school. Math computation and application were low average.

Academic achievement in showed students lacked many of the skills necessary to be successful in middle and high school. Grades were assigned as holistic scores on a mastery learning scale of 0 = F, signifying little to no effort, higher F's of 1–2, minimal passing of 2.5, and letters assigned by 3 = D, 4 = C, 5 = B, and 6 = A. Traditional averages were not assigned, as the grade scale worked on the principle of mastery learning. Initial grade averages for both groups revealed the average grade was a D for math and language arts (standard deviation for both was from an F to a B). BASI-S scores showed students, on average, were far behind academically, and grades were mostly poor.

### 3.8 Multiple Regression

Before developing a regression model, assumptions for the parametric test of multiple regression had to be met. Two regression models were developed: math grades and English grades. The dependent variables were grades, and backward multiple regression analyses were run for each subject matter. Math grades are explored first and then English grades. For each dependent variable, the following assumptions were checked: multicollinearity, linearity, absence of outliers, homoscedasticity, normality, and independence (O'Brien & Scott, 2012).

**Assumptions.** Assumptions were checked for both the math and language arts multiple regression models. The criterion variable was math grades after three weeks. A backward regression model was run to explore relationships, and a model was selected. All assumptions were tested.

Multicollinearity was tested by checking the VIFs for independent, continuous variables. Since the values for VIF were under 4–10, the variables were not considered collinear. Tolerance was also found to be adequate. The condition index revealed no predictor variable had correlation greater than .90 (Hair, Black, Babin, & Anderson, 2009). One concludes the independent variables did not predict each other.

Linearity of continuous variables was tested using partial plots. Scatterplots revealed if the residuals were normally distributed by visual inspection. Because there were three independent variables, three scatterplots were examined. There were no curvilinear patterns. Also, since there were no problems with normality or homoscedasticity, the model was considered linear. Outliers were tested with casewise diagnostics. There were no outliers, and residuals did not reveal any values had high influence or leverage. The conclusion was there were no outliers.

Homoscedasticity was tested to see if the data were evenly distributed. Scatterplots were used and were found to be normal to satisfy homoscedasticity, as most residuals were within -2 or +2 standard deviations. White's test can help check for violation of homoscedasticity, as visual inspection can be difficult (Berenson, 2013). Using Microsoft Excel, the abridged White's test was conducted to test for heteroscedasticity in math ( $F[2,69] = 2.892, p = .062$ ) and language arts ( $F[2,69] = 1.894, p = .158$ ), failing to reject the null hypothesis the data were homoscedastic.

All predictor variables were examined for homoscedasticity. Residuals within +/- 3.3 standard deviations, for samples under 1000, was used as the standard to confirm absence of heteroscedasticity (Tabachnick, Fidell, & Ullman, 2007). No problems with homoscedasticity were found.

Normality was tested by examining the Q-Q plot. The Q-Q plot compares theoretical to actual residuals to determine if both samples were derived from the same sample. The residuals were close to the best-fit line, suggesting the predicted values and actual values were within a normal range. Since the study was cross-sectional as opposed to longitudinal, all values were gathered independently from each other. There were no concerns. A further inference was because normality and homoscedasticity were met, linearity can be assumed for the model for language arts. Overall, the model showed good fit. All assumptions were met.

**Math multiple regression analysis.** Since all assumptions for multiple regression were met, a backward approach was used to construct a model for multiple regression analysis of academic achievement and noncognitive factors on Mathematics grades after three weeks. ANOVA results (Table 2) indicated the model was a significant predictor of math grades,  $F(3,68) = 7.879$ ,  $p = <.001$ , meaning one can conclude the results were not by chance.

Table 2

*ANOVA: Math Grades After Three Weeks Linear Regression*

				Mean		
Model		Sum of squares	df	square	F	p
1	Regression	68.730	3	22.910	7.879	<.001
	Residual	197.714	68	2.908		
	Total	266.444	71			

Multiple regression analysis was used to test if noncognitive and academic factors significantly predicted students' grades after three weeks in math. All assumptions were met. The results of the regression indicated the three predictors explained 22.5% of the variance ( $R = 0.508$ , adjusted  $R^2 = .225$ ,  $F[3,68] = 7.879$ ,  $p = <.001$ ).

When math grades after three weeks were predicted, BASI verbal standardized score ( $\beta = 0.047$ ,  $b = 0.314$ ,  $p = .004$ ), social self-esteem ( $\beta = 0.050$ ,  $b = 0.386$ ,  $p = <.001$ ) and prosocial ( $\beta = 0.259$ ,  $b = 0.255$ ,  $p = .022$ ) were significant predictors (Table 3). The partial correlations revealed each variable provided a unique value for the model: BASI verbal ( $r = 0.309$ ,  $p = .004$ ), social self-esteem ( $r = 0.372$ ,  $p = <.001$ ), and prosocial ( $r = 0.245$ ,  $p = .022$ ). Unstandardized coefficients can be used to build a predictive model. The final predictive model, derived from Table 3, was

$$\text{Math Grade—3 wks} = -7.366 + (0.047 * \text{BASI SS R}) + (0.050 * \text{Soc. SE}) + (0.259 * \text{Pro.}).$$

After including all predictor variables, three variables produced the strongest model, as shown in Table 3. One predictor, BASI SS math, confounded other variables and was removed. Standardized test scores for verbal as measured by BASI (BASI SS R), social self-esteem (SSE), and Strengths and Difficulties Questionnaire–Prosocial (SDQ–PRO) were significant. Standardized coefficients showed all three variables had significance from 0.255 to 0.386. Grit, math academic self-concept, state self-esteem, and math ability were not statistically significant. Other variables which did not show significance were BASI Math Computation and BASI Math Application.

Table 3

*Coefficients: Math Grades After Three Weeks Linear Regression*

Model	Unstand	SE	Stand.	T	p	95% CI		Collinearity statistics	
						Lower	Upper	Toleranc e	VIF
1 (Intercept)	-7.366	1.994		-3.695	<.001	-	-3.388		
SDQ-PRO	0.259	0.111	0.255	2.344	0.022	0.038	0.479	0.923	1.083
SSE	0.050	0.014	0.386	3.562	<.001	0.022	0.078	0.930	1.075
B SS R	0.047	0.016	0.314	2.962	0.004	0.015	0.079	0.972	1.029

*Note.* Unstand. = unstandardized; *SE* = standard error; Stand. = standardized; CI = confidence interval; SDQ-PRO = Strengths & Difficulties Prosocial; SSE = social self-esteem; B SS R = BASI standardized score for verbal.

The best predictors for grades in math were standardized scores in verbal, social self-esteem, and prosocial skills. For the model, the results were statistically significant ( $p < 0.001$ ) and each predictor variable showed adequate alpha levels as well. The model explained 22.5% of variation in students' grades in mathematics for first-time detained juvenile delinquents (adjusted  $R^2 = 0.225$ ).

Power analysis examined if effect size and sample size were adequate. Using Soper's (2019) calculator, the multiple regression analysis was found to be adequate ( $R^2 = 0.258$ ,  $f^2 = 0.348$ , power = 0.8, 3 dependent variables,  $p = .05$ , sample size needed = 35). The effect size of Cohen's  $f^2 = 0.348$  suggested a moderate to high effect and sufficient size. G\*Power 3 was used for post hoc testing of power (Faul, Erdfelder, Buchner, & Lang, 2009). Power was computed to be 0.9904, which was high (noncentrality parameter  $\lambda = 25.9273$ ;  $F$ -crit = 2.7395; numerator  $df = 3$ ; denominator  $df = 68$ ). The conclusion was power was high, and the results can be considered robust.

**English multiple regression analysis.** Similar to the math multiple regression model, all assumptions were met, and using a backward approach, a multiple regression model was constructed. The predictor variables were academic achievement and noncognitive factors regressed on English grades at the three-week mark. ANOVA results, shown in Table 4, indicated the model was a significant predictor of English grades,  $F(3,68) = 10.225$ ,  $p = < .001$ , meaning one can conclude the results were not by chance.

Table 4

*ANOVA: Language Arts Grades After Three Weeks Linear Regression*

Model		Sum of squares	df	Mean square	F	p
1	Regression	87.402	3	29.134	10.225	<.001
	Residual	193.761	68	2.849		
	Total	281.163	71			

Multiple regression analysis was used to test if noncognitive and academic factors significantly predicted students' grades after three weeks in English. All assumptions were met. The results of the regression analysis indicated the three predictors explained 28.0% of the variance ( $R = .558$ , adjusted  $R^2 = .280$ ,  $F[3,68] = 10.225$ ,  $p = < .001$ ).

When English grades after three weeks were predicted, the BASI verbal standardized score ( $\beta = 0.056$ ,  $b = .360$ ,  $p = < .001$ ), social self-esteem ( $\beta = 0.041$ ,  $b = .312$ ,  $p = .004$ ) and prosocial ( $\beta = 0.375$ ,  $b = .359$ ,  $p = .001$ ) were found to be significant predictors. The partial correlations revealed each variable provided a unique value for the model: BASI verbal ( $r = 0.355$ ,  $p = < .001$ ), social self-esteem ( $r = 0.301$ ,  $p = .004$ ), and prosocial ( $r = 0.345$ ,  $p = < .001$ ). The overall model fit was adjusted  $R^2 = 0.280$ . Unstandardized coefficients can be used to build a predictive model. The final predictive model, developed from Table 5, was

LA Grade—3 wks =  $-8.046 + (0.056 \times \text{BASI SS R}) + (0.041 \times \text{Soc. SE}) + (0.375 \times \text{Pro.})$ .

With English grades at three weeks as the criterion variable, standardized test scores for verbal as measured by BASI (BASI SS R), social self-esteem (SSE), and Strengths and Difficulties Questionnaire—Prosocial (SDQ—PRO) were statistically significant as predictor variables. Prosocial and reading accounted for most of the standardized correlation. As with math grades, grit, math academic self-concept, state self-esteem, and math ability were not shown to be statistically significant. The values are shown in Table 5.

Table 5

*Coefficients: Language Arts Grades After Three Weeks Linear Regression*

Model	Unstand.	SE	Stand.	t	P	95% CI		Collinearity statistics	
						Lower	Upper	Tolerance	VIF
1 (Intercept )	-8.046	1.973		-4.077	<.001	-11.985	-4.108		
SDQ—PRO	0.375	0.109	0.359	3.427	0.001	0.157	0.593	0.923	1.083
SSE	0.041	0.014	0.312	2.990	0.004	0.014	0.069	0.930	1.075

B SS R	0.056	0.016	0.360	3.523	<.001	0.024	0.088	0.972	1.029
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*Note.* Unstand. = unstandardized; *SE* = standard error; Stand. = standardized; CI = confidence interval; SDQ–PRO = Strengths and Difficulties Questionnaire–Prosocial; SSE = social self-esteem; B SS R = BASI standardized scores for verbal.

As in math, the best predictors for grades in English were standardized scores in verbal, social self-esteem, and prosocial skills. Each independent variable had statistical significance, as well as the entire model. The model explained 28.0% of variation in students' grades in English for first-time-detained juvenile delinquents (adjusted  $R^2 = 0.280$ ).

Soper's (2019) calculator was used to conduct power analysis. The model was found to have adequate power ( $R^2 = 0.311$ ,  $f^2 = 0.451$ , power = 0.8, 3 dependent variables,  $p = .05$ , sample size needed = 28). The effect size of Cohen's  $f^2 = 0.451$  suggested the findings have a high effect and sufficient size. G\*Power 3 was also used for post hoc testing of power (Faul et al., 2009). Power was computed to be 0.9986, which was high (noncentrality parameter  $\lambda = 33.4172$ ;  $F$ -crit = 2.7395; numerator  $df = 3$ ; denominator  $df = 68$ ). The conclusion was power was high, and the results can be considered robust.

The results of the research questions for correlation with students' grades found similar predictor variables. Reading skills, social self-esteem, and prosocial skills predicted math and English grades. In the results for the first question for language arts grades, the proposed model was statistically significant using ANOVA ( $F[3,68] = 10.225$ ,  $p = <.001$ ), the adjusted  $R^2 = 0.280$  ( $p = <.001$ ), and a high effect size ( $f^2 = 0.451$ ). For the second research question for mathematics grades, the proposed model was statistically significant using ANOVA ( $F[3,68] = 7.879$ ,  $p = <.001$ ), adjusted  $R^2 = 0.225$  ( $p = <.001$ ), and a moderate to high effect size ( $f^2 = 0.348$ ). Power was adequate for both studies. In the present study, reading comprehension mattered as much as being socially mature and demonstrating prosocial skills. Essentially, student success depended on being able to listen, read, and comprehend, and the youths refrained from behavioral problems and attempted to be pleasing to others.

## 4. Discussion

"The high recidivism and low school re-engagement data serve as an urgent call to action. It is clear that greater investments in JDC [juvenile detention center] staffing, professional development, instruction and transition planning are needed" (Benner et al., 2016, p. 43). Juvenile delinquents have a lengthy history of failure. Demographic results in the study were comparable to previous research findings conducted nationally, finding juvenile delinquents had the following characteristics: (a) well behind similarly situated peers, (b) present with high rates of mental illness, and (c) self-perceptions of acceptable academic progress which do not align with school grades, behavior, and graduation. The recommendations start by briefly outlining prior work to improve outcomes for juvenile delinquents and end with recommendations of how current findings and theory should be used to improve educational programs for juvenile delinquents.

For low-achieving students with behavioral issues, self-appraisal did not match normal expectations (Walters, 2020). Some questioned if grit was a construct, as one large-scale study suggested grit was conscientiousness, and improving grit had low effect versus a focus on perseverance (Credé, Tynan, &

Harms, 2017). Correlation and regression did not show significance with grit. While some factors correlated to grit, one would hypothesize because of the low academic achievement, lack of success in school, and pervasive behavioral problems, students would show either low grit or negative correlation. One study found grit was a protective factor against delinquency (Guerrero, Dudovitz, Chung, Dosanjh, & Wong, 2016). Unlike the Duckworth and Quinn (2009) studies which correlated grit with high academic achievement, in the present study, students in juvenile detention had similar grit to high-achieving students but pervasive failure. Possible causes were in the face of persistent failure, students distorted causes of failure and appraised ability disassociated from results to protect the self.

Many found academic self-concept predicted academic achievement, with a low to moderate effect size (Ghazvini, 2011; Stankov & Lee, 2014; Susperreguy, Davis-Kean, Duckworth, & Chen, 2018). Noncognitive factors, such as psychosocial and behavior, influenced grades as much as prior grades and standardized achievement (Casillas et al., 2012). Yet, in the current study, academic self-concept did not correlate with academic achievement as found in previous studies). Juvenile delinquents had comparable academic self-concept as students in the general population, and grades were not impacted by this factor. Like grit, there was a disassociation between effort and results.

Prosocial, social self-esteem, and reading ability were shown to be connected by language and expressive communication. Low intelligence and psychopathic behavior negatively impacted decision making and cooperation, and juvenile delinquents demonstrated low empathy by practicing self-serving cognitive distortions (Baetz et al., 2019; Barriga, Sullivan-Cosetti, & Gibbs, 2009; Stams et al., 2006). Students able to play the game, where the youths listen, read adequately, and understand social situations, excelled. In addition, students with empathy and people-pleasing behavior, the hallmarks of prosocial behavior, found ways to be successful in juvenile detention centers in the face of poor math skills and other psychosocial problems.

The present research supports current findings communication problems and antisocial behavior were prevalent and detrimental to academic achievement, but there was an important divergence. Possibly 90% of students in juvenile detention have impaired receptive vocabulary skills, and being agreeable and conscientious were found at odds with antisocial behavior (Jones, Miller, & Lynam, 2011; Lansing et al., 2013). Juvenile who persisted across the lifespan had a history of aggressive behavior and drug and alcohol abuse (Assink et al., 2015). Well into midlife, juvenile delinquents had 41% odds of being unemployed and 141% increased odds of having a mental illness (Drury, DeLisi, & Elbert, 2019).

Long theorized was reading was a factor causing juvenile delinquency, but the findings of this study problematize those conclusions. Communication and language disorders have been found to start in childhood and were much higher in adult prisons, and such disorders related to psychological, emotional, and behavioral problems (LaVigne & Van Rybroek, 2011; Søndena, Wangsholm, & Roos, 2016). For example, psychopathy related to poor reading outcomes (Vaughn et al., 2011). The Texas Tiered Instructional Model offered four evidence-based steps to teach reading in juvenile detention (Williams, Wexler, Roberts, & Carpenter, 2011). The missing fifth step in the Texas model and others was an inability to read was more than lack of instruction. Students had severe social and emotional problems, exacerbated by communication disorders which largely goes undiagnosed and untreated (Moncrieff, Miller, & Hill,



2018). Results of the current study suggested juvenile delinquents have severe reading problems, but other factors, such as prosociality and social self-esteem, should be considered.

The findings offered a mediation about the root causes of juvenile delinquents, calling for further analysis. Numerous studies documented poor reading skills of juvenile delinquents, which led some to suggest failing to teach students to read led to juvenile delinquency (Baker & Ireland, 2007; Malmgren & Leone, 2000; Warnick & Caldarella, 2015; Wheldall & Watkins, 2004). Christle and Yell (2008) called for preventing reading problems as a way to prevent or reduce juvenile delinquency. Instead of presupposing poor or little reading instruction causes delinquency, problems with communication coexist with learning reading over the course of elementary school. Combined, students likely did not get along socially with others, struggled with empathy and teacher pleasing behavior, and experienced difficulty in reading (and in social and prosocial interactions) connected with an inability to communicate effectively. The conclusion juvenile delinquents experienced persistently poor schools and teachers seemed less likely than the interaction of social self-esteem, prosocial skills, and verbal abilities were all mediated by communicative abilities. The ideas of instilling helpability and coachability in juvenile delinquents were suggested by the regression analysis.

Positive prosociality correlated with reduced aggression and delinquent behavior (Padilla-Walker, Memmott-Elison, & Coyne, 2017). Teaching and promoting prosocial behavior have been shown to reduce aggressive conduct and improve academic achievement (Caprara et al., 2014; Gerbino et al., 2018). Pull out and counseling sessions probably do not provide enough intensity in juvenile detention centers. Without development of social skills and prosocial ability, a strict focus on academic achievement had shown little chance of success. Students in short-term juvenile detention centers with higher engagement and commitment perform better behaviorally and academically (Walden, Stancil, & Verona, 2019).

Juvenile detention centers should embrace the alternative model and develop cross-disciplinary subjects focused on improved communication in reading, prosociality, and social interaction centered around teaching helpability and coachability. Antisocial behavior and impulsivity significantly predict criminal behavior (Bobbio, Arbach, & Illescas, 2020; Geerlings, Asscher, Stams, & Assink, 2020). The present research results suggested communication problems remediation should be at the center of many juvenile's learning problems. Unfortunately, schools in juvenile detention centers might have smaller classes and counseling after school, but most operate closer to traditional schools than focusing on the diverse needs of incarcerated juvenile delinquents.

Prior research findings, plus the current study, suggested schools should shift focus from solely academic or cognitive factors to one which also includes social and emotional factors of prosociality and social regulation from first contact to postrelease (Copp, Giordano, Longmore, & Manning, 2020). Preparing students to reenter society starts with understanding the complex interplay of academic skills, prosocial deficits, and social self-esteem issues to develop and implement programs which produce successful outcomes (Jäggi, Kliwer, & Serpell, 2020). Future research should operationalize current findings to maximize student growth based on shifting from the collective to a focus on individual-level traits (Gearhart & Tucker, 2020). Future research should look at making prosociality and social skills as key performance indicators for juvenile delinquents, and each student should have an individual case study to develop a personal plan.

## 5. Limitations

The present study used instruments with adequate reliability and validity. Testing conditions were followed to standardize results. The  $R^2$  and adjusted  $R^2$  were close in value to each other in the mathematics and language arts multiple regression analyses, suggesting the models were valid and reliable (Hair et al., 2009). The instruments used were considered reliable and credible for the purposes. The same variables predicted both regression models, and when connected with students' demographics (e.g., persistent failure, behavioral problems, poor academic achievement), the results related to previous findings for the student population. Furthermore, White's test, though useful for testing homoscedasticity, can be used for model specification (Berenson, 2013; Meuleman, Loosveldt, & Emonds, 2015). In the current models, White's test suggests both models were not misspecified. The current findings were consistent with other studies which found poor academic achievement and prevalence of mental illness in juvenile delinquents (Krezmien et al., 2008; Wood, Wood, & Mullins, 2008). Though the population was sampled by convenience, the sample size and power were adequate. Furthermore, the sample was from a large geographical area with an urban and rural population.

Despite the findings, caution should be exercised in interpreting the results. External validity should be considered by numerous factors. First, the sample size was comparatively small, and the sample was drawn from one juvenile detention center in a small urban area. Secondly, correlation analysis did not reveal grit or academic self-concept directly impacted students' grades, and there would need to be further investigation on how students developed normal grit and academic self-concept which did not match achievement. Thirdly, the instruments used were screeners, brief, and could be better developed with follow-up investigations. Lastly, regression analysis only correlated grades for a small period; longer periods of incarceration change students, and examining variables before, during, and after would offer more insight. Using larger random samples and mixed-methods research could strengthen findings and add credibility.

## 6. Conclusion

Leaders in the education in juvenile detention should be freed from many state mandates, as complex cases and needs should dictate programming, not a one-size-fits-all program. Rather than seeing problems as technical, adaptive leaders work on continuous improvement by collaboration and improved dissemination of information (Baltaci & Balci, 2017). A framework for analyzing and tackling problems can be taught, and leaders can support and enable faculty members to use adaptive leadership skills by changing goals, beliefs, and habits in everyday practices (Boylan, 2018; Heifetz, Grashow, & Linsky, 2009). Juvenile delinquents, as a group, have difficulty appraising one's self, but how self-appraisals manifest in each juvenile varies to the degree where each facility should continuously update and shift programming to meet the needs of a highly transient population.

Within the confines of existing research, there should be a shift in theory and a new framework individualized to each juvenile (Coker, 2020). Preventive measures and improved resiliency do not teach communication skills connected with reading, social self-esteem, and prosocial skills. Many settings have been found to teach academic buoyancy and resiliency to juveniles to cope with anxiety and failure (A. J.

Martin, 2013). Though the characteristics of psychopathy and antisocial personality disorders were related to recidivism, there was not one instrument or finding which predicts poor outcomes (Pechorro, Seto, Ray, Alberto, & Simões, 2019). Students in juvenile detention need more intensive services than a second-tier intervention or 20 minutes extra per day for response to intervention. New instruments and programs which move beyond observed behavior are necessary to cause long-term change. Redefining schools around programs which explicitly focus on reading ability, improved prosociality, and positive social self-esteem hold promise to improve outcomes of juvenile delinquents.

The results of this quantitative, correlation study suggested reading ability, prosociality, and social self-esteem positively impacted academic outcomes for first-time detained juvenile delinquents. Findings from special education can be extrapolated to juvenile detention: Depressed academic achievement and behavioral problems have shown a connection, and prevention through positive supports has shown promise in juvenile correctional facilities (Algozzine, Wang, & Violette, 2011; Jolivet, 2016). Juvenile detention centers need to redefine what education means for newly incarcerated students, with a focus on improved engagement (Pytash & Kosko, 2020). Schooling for students has to move beyond pure academic concerns, as developing positive peer relationships and inculcating prosocial skills show great promise. Leaders will have to challenge the current approaches which maintain the status quo and move schooling for juvenile delinquents to be redefined differently than the classic models of schooling. Without change, the current trajectory of failure and recidivism will continue.

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# **Optimization of Hybrid Renewable Energy Systems for Power Generation: A Bibliometric Review**

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## **Abstract**

*The use of Hybrid Power Generation Systems through renewable sources has been gaining prominence, since it is a way to reduce the dependence on fossil fuels, contributing to the reduction of pollutant gas emissions to the environment. Due to the higher operational complexity, the multiplicity of options and constant improvement of these units, how to optimize these systems is still a subject of present studies. Considering the attention that this topic has received from the academic community, the challenges for mapping and identifying the relevant literature, this article provides a macroscopic view of the scientific literature on the Optimization of Hybrid Renewable Energy Systems (HRES) for energy generation, through analysis bibliometric. The research was developed using the Web of Science database, obtaining a total of 439 articles between 2010 and 2020, where the results were interpreted through the VOSviewer software. The results showed that the number of related publications is gradually increasing, with India as the leading country. The University of Malaya is the institution with a higher number of registers, with 14 entries. Most publications fit into the "Energy Fuels" category, with the magazines "Renewable Sustainable Energy Reviews" and "Renewable Energy" as the most influential in terms of the number of publications, as well as the United States and China are the countries with most research collaboration. Besides, the most cited articles and the recurrence and distribution of keywords indicate the future directions of research. In short, this study contributes valuable information to researchers on the topic.*

**Keywords:** Hybrid renewable energy systems; Hybrid PV/wind/diesel energy system; Optimization, Bibliometric analysis.

## 1. Introduction

The quick depletion of fossil fuels on a global level has demanded an urgent development of alternative energy sources to satisfy the crescent requirement of energy. One of the main reasons for the use of clean energy sources to electricity generation is the decrease in the dependence on fossil fuels, which increments the effects of global warming with alarming climate changes generating negative environmental impacts during the last decades (Bukar and Tan 2019).

In the present times, renewable energy sources as solar, wind, hydro and biomass energy have received significant attention to the use of electricity in several geographic locations around the world (Faccio et al. 2018). These sources not only decrease carbon dioxide (CO<sub>2</sub>) emissions, reducing the necessity to energy generation from fossil fuels, but also provide an energy system more capable of handling failures and less exposure to fluctuating fuel prices (Movahediyani and Askarzadeh 2018). Despite the uncountable advantages of renewable energy sources, its intermittent nature results in the necessity to integrate these generation systems in a suitable combination for a reliable system, constituting a hybrid system based on renewable energy sources (Anoune et al. 2018).

HRES can consist of a converge renewable energy system with a wind turbine, photovoltaic panel, hydro turbine, fuel cells and other elements as conventional diesel generator, microturbine and storage devices like a battery, and this system can be all or just part of them (Bhandari et al. 2015). According to Ferrari et al. (2018), hybrid energy generation systems are an interesting solution to the electricity in remote regions, outside of the coverage of users. Considering the extension of the central electrical grid to those remote geographical regions, with a low population density is not financially viable and practicable (Ogunjuyigbe et al. 2016).

Due to the existence of several technologies and energy systems inside of the HRES, the management and optimization of these systems are highly relevant (Mehrpooya et al. 2018). The HRES optimization problem can be solved through the simultaneous solution of three subproblems (synthesis, design and operations problems), which is already done in other engineering problems to reach a satisfactory result. According to Kaldellis (2010), the synthesis problem consists of defining the type of components that will constitute the HRES; the design problem consists of sizing the components of the system and the operation problem consists of defining an operation strategy that attends with the restrictions defined by the final purpose of the system.

As pointed out by Rahman et al. (2016), the optimization of a hybrid energy system to comply with the charge requirements with minimums investment and operations costs is one of the main challenges of the system. Thus, it is absolutely important that the designers find an ideal optimization technique to the sizing of the system with celerity and accuracy, ensuring that the hybrid system might be able to function in ideal conditions in terms of energy investment and reliability (Zhou et al. 2010). Over the years, lots of research in the literature has been using optimization methods to configure a satisfactory HRES in remote areas.

One of the optimization methodologies to the energy system is the usual traditional methods, as well as the artificial intelligence methods, hybrid methods, and the use of Software tools (Lian et al. 2019).

In the last years, the scientific production has been increasing considerably, making it even more difficult for researchers to follow the relevant literature in their field (Zupic and Čater 2015). In this sense, this article aims to provide a macroscopic view of the current scientific literature about the Optimization of Hybrid Renewable Energy Systems for energy generation, through analysis bibliometric. Also, this paper provides valuable information that can support the scientific community to identify the relevant perspectives and issues related to the current state of development about this topic. The article is structured in three sections: methodology approach used in the bibliometric analysis; the results and discussion section, and the final thoughts.

## 2. Methodology

The bibliometric analysis was used to analyze and to identify relevant aspects of international scientific production on Optimization of Hybrid Renewable Energy Systems published between 2010 and 2020. It described as an applied statistic method used to assess and quantify the number and trend increase of a specific subject (Mao et al. 2018). The analysis with a focus on bibliometric parameters enables researchers to examine the bibliographic material from an objective and quantitative perspective, making it useful in organizing information on a specific knowledge area (Castillo-Vergara et al. 2018). This type of analysis can support the researchers who evaluate the progress of scientific activity to identify relevant issues both in research carried out and in evolution (Montero-Díaz et al. 2018). Besides that, this analysis has been understood as more objective and more reliable than traditional review methods (Weinand 2020).

In order to write this article and define a research workflow, based on bibliometric methods proposed by Zupic and Čater (2015), this study fits our reality. Below, we present five of its steps in Figure 1.

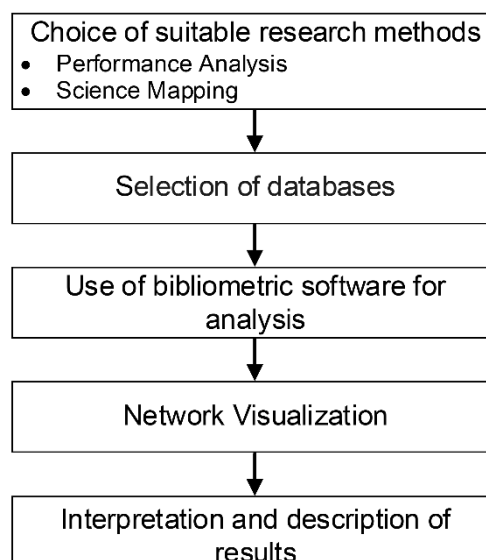


Figure 1. Workflow for bibliometric surveys

### 2.1 Choice of suitable research methods

The bibliometric analysis has two uses: performance analysis and science mapping (Cobo et al. 2011). The performance analysis seeks to evaluate the characteristics of scientific production, such types, languages, journals, and countries, based on bibliographic data to determine the trends or critical or critical points in a given research area. On the other hand, the science mapping aims to show the structural aspects of scientific fields (Börner et al. 2003; Hou et al. 2015). The analysis of the corpus was done in two stages: the performance analysis and science mapping analysis.

#### 2.1.1 Performance analysis

At this stage, we analyzed some aspects as the number of publications produced per year, languages used by the authors, type of document, distribution of productions by countries, institutions and authors and categories covered. Besides, the most influential magazines and publications are also subject to analysis. Bibliometric indicators are highly useful to represent the bibliographic material, providing a representative and informative perspective of the data (Cancino et al. 2017). This study uses the entire number of articles and citations to measure its productivity and influence (Cancino et al. 2017), as well as the impact factor (IF) and the H index. The impact factor constitutes a useful indicator to measure the quality of a magazine, while the H index measures the productivity and the impact of the researches published by scientists and scholars (Mao et al. 2015). The H index is adopted to measure the author's influence, while the IF is used to evaluate the magazines (Hou et al. 2015).

#### 2.1.2 Science mapping

At the science mapping stage, we used the co-author analysis, as well as the co-citation and co-word analysis, being those techniques considered the most useful to the development of the science mapping (Cobo et al. 2011). Initially, we developed the analysis of the authors and their affiliations (co-author analysis) between 27 most productive countries. The co-author analysis of scientific publications is assumed to be a collaborative measure, reflecting stronger social ties than other kinship measures, making it suitable for examining social networks (Zupic and Čater 2015).

Then, co-citation analysis is performed, which is considered the most used and validated bibliometric method, connecting documents, authors, or magazines (Zupic and Čater 2015). Co-citation is the frequency that two units are cited together and can identify the knowledge base of a topic/research field and its intellectual structure (Leung et al. 2017). Specifically, it analyzed the co-citation of authors (ACA) aiming to identify relevant authors and connect them through citation entries (White and McCain 1998).

After all, the co-word analysis is performed, which constitutes one of the most used techniques to execute the content analysis, considering that the researchers use expressions and keywords that indicate the central literature central content as a research object (Du et al. 2014). Thus, the principal trends and changes that happen in scientific research, inside of a specific area, can be analyzed from a quantitative point of view. This study considers the keyword in titles and abstracts of publications, aiming to identify relevant aspects of the research in a specific field (Mao et al. 2018). In addition to relating the distribution of keywords according to the categories research subjects, purposes, methods and research areas (Gao et al. 2016).

### 2.2 Selection of databases

Aiming to verify how the scientific production has developed the research field related to the Optimization of Hybrid Renewable Energy Systems, it was carried out a research in the main collection of Clarivate

Analytics Web of Science database, which constitutes a selective list of journals and conference proceedings, with indexing coverage from 1900 to the present day (Clarivate\_Analytics 2020). The chosen database functions as a research mechanism, since it is the most accepted database used for the analysis of scientific publications (Van Nunen et al. 2018; Yang et al. 2013). Besides, this database is compatible with the VOSviewer bibliometric analysis software, transferring abstracts, references, citations, authors, institutions, countries, among others (De Carvalho et al. 2019).

In order to seek the publications, the keywords used were “Hybrid renewable energy system”, “Hybrid PV/wind/diesel energy system”, “Optimization”, using the boolean operator “OR” between the first and the second term and the operator “AND” between the second and the third term, so, in this order, articles on “Optimization” would be shown, both in the “Hybrid renewable energy system” or “Hybrid PV/wind/diesel energy system” approach. The term “Hybrid renewable energy system” was specified in the field title, for search in the titles of publications, while for the terms “Hybrid PV/wind/diesel energy system” and “Optimization” the field topic was described, including the analysis in the title, abstract and keywords of publications. The defined time interval was 2010-2020 and the search was refined by document types (Article or Review).

### ***2.3 Use of bibliometric software for analysis***

The data obtained from Web of Science were removed to be processed by the science mapping software VOSviewer, and for making graphs and tables, Microsoft Excel software was used. These procedures were carried out to analyze the bibliographic performance and the evolution of the research field studied through science mapping.

The VOSviewer software (version 1.6.15) allows the creation, visualization and exploration of maps with based on bibliometric network data (Van Eck. and Waltman 2020). VOSviewer can be used to author construct maps or maganized based on co-citation data or to construct maps of keywords based on co-occurrence data (VOSviewer 2020), being its main functionality to exhibit large bibliometric maps in an easy to interpret way (Van Eck and Waltman 2010). In addition, the main advantage of this program over most information technology programs available to bibliometric mapping is its incidence on the graphical representations of maps (Castillo-Vergara et al. 2018).

### ***2.4 Network Visualization***

Based on a long-distance analysis, the network visualization through maps allows us to identify groups of related items more easily (Van Eck and Waltman 2010). In the network visualization, the items are represented by its label and circle. Its size is determined by the weight of the item and the color of an item is determined by the cluster to which the item belongs. Also, the lines between items represent links (Van Eck. and Waltman 2020). Network analysis allows us to perform a statistical analysis on the map produced in the posterior stage (Cobo et al. 2011).

### ***2.5 Interpretation and description of results***



In this stage, the results obtained from the analysis of bibliographic performance and science mapping are interpreted. In the interpretation step, the analyst looks to discover and extract useful knowledge that could be used to make decisions on which policies to implement (Cobo et al. 2011).

### 3. Results and discussion

In this section, it will present the results of bibliographic performance and science mapping analysis.

#### 3.1 Bibliographic performance analysis

##### 3.1.1 Distribution of publications by type of publication, language and year

The data used in this study was obtained on May 18, 2020, with a total of 439 publications related to the Optimization of Hybrid Renewable Energy Systems. In these publications, it was identified 389 research articles that represent 89% of all publications, and 50 review articles, which represents 11%. We identify that most publications were written in English, with a total of 438 articles in this language, while only one was written in Russian, showing the role of English as a tool to disclose scientific research even in countries where English is not a native-language as China, India, Italy, and Spain

In order to verify the temporal evolution of publications, we present the number of articles published per year in Figure 2. According to the graph, the number of publications between 2010 and 2020 has shown an increasing trend. In the past five years, the number has grown by 14% per year on average. This increase may be related to the development of renewable energies and the incentive actions for their greater use. In the period analyzed, 2019 was the year with the largest number of records, with a total of 111. As of May 2020, 44 papers have been published. The annual growth pattern may indicate a trend of continuity in the increase in research in the area in subsequent years.

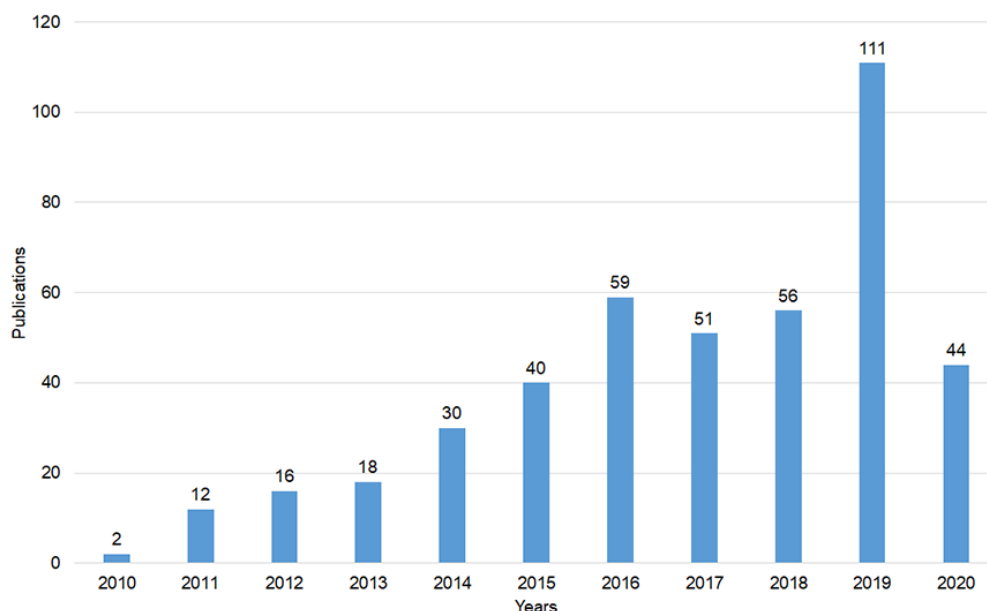


Figure 2. Distribution of publications by year

##### 3.1.2 Distribution of publications by countries, institutions and authors

In this period, 72 countries have been contributing to articles on Optimization of Hybrid Renewable Energy Systems. The 10 countries with the largest number of records developed in the analyzed period are responsible for 74% of scientific production, with 323 of 439 publications. Among these countries, seven belong to the Asian continent, two to North America and one to Europe. The country with the largest number of records is India with a total of 69 publications, followed by Iran and China with 42 articles each, and the United States and Malaysia with 28 and 27 studies developed respectively. The number of articles on the topic shows that countries such as India, Iran, China, United States and Malaysia have shown more interest in the optimization of hybrid systems compared to other countries. An analysis of the annual behavior of the number of publications from the five most productive countries on the topic is presented in Figure 3.

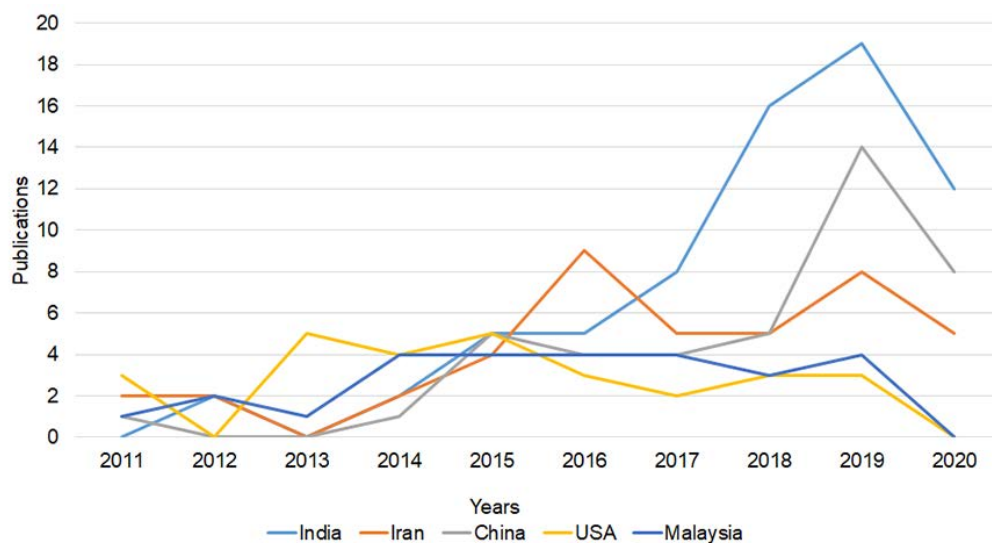


Figure 3. Distribution of the number of publications in the study period

Over the years, India has shown a noticeable increment of the number of scientific productions, in comparison with other countries, achieving the number maximum of publications in 2019, with 19 registers. Besides, India is considered the fourth largest renewable energy market, and today 35% of the energy produced in the country comes from renewable sources and still has a goal of reaching 175 gigawatts of renewable energy capacity by 2022 (REN21 2019). Recently, the renewable energy department in India has seen a notable increase in investment and in the implementation of policies that promote the use of this type of energy, which justifies the efforts in the development of scientific productions on the subject in the country (Das et al. 2019).

Analyzing the annual distribution of publications, we realize that China has presented an increase in the number of publications in the last years, especially in 2019, with 14 registers. The country is leading the global ranking of renewable energy, being considered the largest producer, exporter, and installer of solar and wind technologies in the world (REN21 2019). Recently, it was promulgated in the country several incentive policies on renewable energy sources, promoting their development and use (Lian et al. 2019). In addition, China has established, as part of the actions against climate change, a target of cutting CO<sub>2</sub>

emissions per unit of GDP by 60-65% from 2005 to 2030 (X. Zhang et al. 2016). All of these actions and incentives may be conditioning the progressive increase in the number of publications in the country.

Although the fact that Iran has the same number of publications in the period as China, we notice that the country presented higher stability in the number of studies developed over the years, always with an increasing trend, reaching the maximum number of publications (9) in 2016. Due to its geographical position, the country has an enormous potential for the production of different types of renewable energy, considering the installed solar energy with capacity of 39,777 kW, 10,266 MW by hydroelectric plants and 110.1 MW of wind energy (Khojasteh et al. 2018). In addition, the country has comprehensive plans until 2020 for the production of 5 GW of electricity using renewable energy sources (REN21 2019). Therefore, to achieve this goal, it is necessary to develop more renewable energy, which may be linked to the increase in publications.

According to this study, the United States was the fourth country with a higher number of publications about the theme, showing, over the years, a consistency in the number of publications, fluctuating with 3 records per year, on average. Also, the United States occupies the second place in the global ranking of investment in renewable energy, having invested approximately US \$ 356 billion in the last decade, which corroborates with the great concern and efforts of the country in the development of research on the subject (REN21 2019).

Malaysia was the fifth country with a higher number of articles, showing from 2014 an increment in the number of records, maintaining stability until today. The country has set a goal of 20% of clean energy generation by 2030, which may have influenced the greater interest in publications on the subject (REN21 2019).

Altogether, 538 different institutions are indicated in the publications. Table 1 lists the 10 most relevant institutions in terms of the number of publications on Optimization of Hybrid Renewable Energy Systems. These institutions have been responsible for 84 (19%) publications so far. Among these institutions, two are from Iran, two from Egypt and two from Spain. Malaysia, Qatar, Saudi Arabia and Nigeria are represented by one institution each. The University of Malaya, located in Malaysia, is the institution that stands out with the largest number of publications, 14 in total. Although countries like India, China and the USA are among the most productive countries as shown above, none of the listed institutions belong to these countries, which may indicate that parts of the total number of publications in these countries are spread over several institutions.

Table 1. Institutions with the largest number of publications on Optimization of Hybrid Renewable Energy Systems

Institutions	Number of publications	Country
University Malaya	14	Malaysia
Qatar University	9	Qatar
University of Tehran	9	Iran
Islamic Azad University	9	Iran
King Saud University	8	Saudi Arabia
Mansoura University	7	Egypt

Menia University	7	Egypt
Federal University Technology	7	Nigeria
Universidad de Cadiz	7	Spain
Universidad de Jaen	7	Spain

Between 2010 and 2020, a total of 1276 authors developed works on Optimization of Hybrid Renewable Energy Systems. Authors with up to five studies published on the topic are classified at Table 2. These authors represent only 1% of the total number of authors and they have contributed with 88 articles. The H index, which measures the impact and productivity of the authors, number of citations, average citations and country, are also exposed. As shown in the table, it was possible to verify that the following authors have the largest number of publications and the highest H-indexes, Eltamaly, Ali M (7 and 6), Mekhilef, Saad (7 and 7), Olatomiwa, Lanre (7 and 6) and Jurado, Francisco (7 and 7). As noted, the relevant authors belong to countries on the European and Asian continents.

Table 2. Authors with the largest number of publications on Hybrid Optimization of Renewable Energy Systems

Authors	Number of publications	Citations	H index	Average of citations	Country
Eltamaly, Ali M	7	125	6	17,86	Egypt
Mekhilef, Saad	7	334	7	47,71	Malaysia
Olatomiwa, Lanre	7	332	6	47,43	Nigeria
Jurado, Francisco	7	234	7	33,43	Spain
Mohamed, Mohamed A	6	112	5	18,67	Egypt
Baredar, Prashant	6	267	5	44,50	India
Bartolucci, Lorenzo	5	44	3	8,80	Italy
Cordiner, Stefano	5	44	4	11,50	Italy
Mulone, Vincenzo	5	44	4	11,50	Italy
Khare, Vikas	5	215	4	43,00	India
Fernández-Ramírez, Luís M	5	105	4	21,00	Spain
Yoo, Chankyoo	5	51	3	10,20	South Korea

### 3.1.3 Distribution of publications by categories covered and magazines

The 439 articles found about the research topic were grouped into 51 categories covered within the Web of Science. The table 3 shows the five most influential categories in terms of number of publications. As can be seen, the “Energy Fuels” category is the most embracing with a total of 284 records followed by “Green Sustainable Science Technology” with 132 records. The greater number of publications, mainly in these two categories, shows the interest in the optimization of Hybrid Renewable Energy Systems as a way to reduce the dependence on fossil fuels, contributing to the reduction of pollutant gas emissions to the environment. The “Thermodynamics” category is in third place with 70 publications, followed by “Engineering Electrical Electronic” and “Engineering Chemical” with 55 and 30 publications, respectively.

Table 3. Distribution of the number of publications by category

Web of Science categories	Number of publications	%
Energy Fuels	284	64,5
Green Sustainable Science Technology	132	30,0
Thermodynamics	70	15,9
Engineering Electrical Electronic	55	12,5
Engineering Chemical	30	6,8

The articles on Optimization of Hybrid Renewable Energy Systems on the analyzed period were published in 123 different magazines, being an indicative of the dimension and consolidation that the research on the subject has achieved. Journals with until 11 records and their respective impact factors are listed in Table 4. The impact factor is a useful indicator to measure the quality of a magazine (Mao et al. 2015). This article is used to evaluate the relative influence of periodic related to the topic studied. The impact factor for each individual journal was retrieved from the relative official website. These magazines contain 54% of the publications on the subject of study. “Renewable Sustainable Energy Reviews” and “Renewable Energy” constitute the most productive magazines with a total of 36 publications each, followed by the magazines “Energy”, “Energy Conversion and Management” and “Energies” with 33, 24 and 20 articles, respectively. The magazine that recorded the highest impact factor was “Renewable Sustainable Energy Reviews” with 10,556, which indicates greater influence and quality in relation to the others. “Applied Energy”, despite being in eighth place, has the second largest impact factor, 8,426. As shown in the table, most magazines are related to renewable energy and energy sustainability.

Table 4. Magazines with the largest number of publications on Hybrid Renewable Energy System Optimization

Magazines	Impact factor	Number of publications
Renewable Sustainable Energy Reviews	10,556	36
Renewable Energy	5,439	36
Energy	5,53	33
Energy Conversion and Management	7,181	24
Energies	2,676	20
International Journal of Renewable Energy Research	3,12	19
Journal of Renewable and Sustainable Energy	1,511	15
Applied Energy	8,426	15
International Journal of Hydrogen Energy	4,084	15
Solar Energy	4,674	11
Sustainability	2,592	11

The annual behavior of the publications about Optimization of Hybrid Renewable Energy Systems of the five most productive magazines is shown in Figure 4. Until 2014, most articles were published in “Renewable Sustainable Energy Reviews” and “Renewable Energy”, which initially shows interest in mainly review studies on sustainable energy. Since 2015 with the Paris Climate Convention agreement, which included limiting global warming to less than 1.5 °C and reducing greenhouse gas emissions, the global capacity for renewable energy has been increasing in recent years. to contribute to decarbonization (Weinand 2020). This is visibly noticeable, as from 2015 most of the five magazines increased the number of publications. From 2017 to the current times, magazines such as “Energy” and “Energy Conversion and Management” have been gaining prominence in the number of publications, which shows greater interest in technical, management and energy sustainability aspects of hybrid systems.

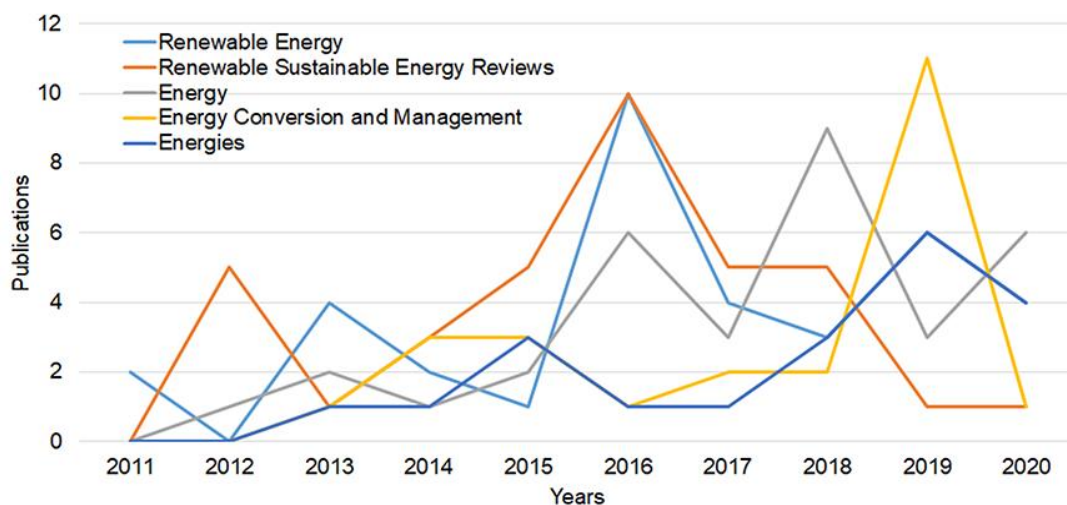


Figure 1. Annual publications about Optimization of Hybrid Renewable Energy Systems from the top five magazines

### 3.1.4 Publications with the highest number of citations

In order to identify the articles that can be considered the most relevant in the scientific production about Optimization of Hybrid Renewable Energy Systems during the study, we found the 10 most cited articles about the theme, as Table 5 shows.

Table 5. Most cited articles among the scientific contributions on Hybrid Renewable Energy System Optimization

Articles	Year of Publication	Total citations	Citations /year	Authors	Magazine
A Review of Hybrid Renewable/Alternative Energy Systems for Electric Power Generation: Configurations, Control, and Applications	2011	351	35,1	(Nehrir et al. 2011)	IEEE Transactions on Sustainable Energy



Hybrid renewable energy systems for power generation in stand-alone applications: A review	2012	333	37	(Bajpai and Dash 2012)	Renewable & Sustainable Energy Reviews
Optimum design of hybrid renewable energy systems: Overview of different approaches	2012	329	36,5	(Erdinc and Uzunoglu 2012)	Renewable & Sustainable Energy Reviews
Review of software tools for hybrid renewable energy systems	2014	281	40,1	(Sinha and Chandel 2014)	Renewable & Sustainable Energy Reviews
Optimal sizing of renewable hybrids energy systems: A review of methodologies	2012	229	25,4	(Luna-Rubio et al. 2012)	Solar Energy
Multi-objective optimization of a stand-alone hybrid renewable energy system by using evolutionary algorithms: A review	2012	196	21,7	(Fadaee and Radzi 2012)	Renewable & Sustainable Energy Reviews
Solar-wind hybrid renewable energy system: A review	2016	172	34,4	(Khare et al. 2016)	Renewable & Sustainable Energy Reviews
Multi-objective optimal design of hybrid renewable energy systems using PSO-simulation based approach	2014	154	22	(Sharafi and ELMekkawy 2014)	Renewable Energy
Energy management strategies in hybrid renewable energy systems: A review	2016	143	28,6	(Olatomiwa et al. 2016)	Renewable & Sustainable Energy Reviews
Optimization of an off-grid hybrid PV-Wind-Diesel system with different battery technologies using genetic algorithm	2013	143	17,8	(Merei et al. 2013)	Solar Energy

The number of citations is commonly used to verify the impact of a specific article (Mao et al. 2015). However, the measurement of scientific production tends, based on the number of citations, to favor older articles. Since, the number of citations of a publication is highly correlated with the time, considering the date of its publication (Qiu and Chen 2009). For this reason, the articles are also analyzed according to the number of citations per year to adjust the difference in the length of time since their publication. Table 5 shows that the most cited article is entitled “The Review of Hybrid Renewable/Alternative Energy Systems for Electric Power Generation: Configurations, Control, and Applications” with a total of 351 citations since its publication in 2011. However, when analyzing from the number of citations for years, we find that the article entitled “Review of software tools for hybrid renewable energy systems”, published in 2014 and which occupies the fourth place in terms of the number of citations, has a higher number of annual citations with an average of 40,1. Considering the articles listed, eight are characterized as review articles and two as articles. In particular, review articles receive more citations than regular research papers, because they summarize the results of many articles (Gao et al. 2016). In general, the ten most relevant articles address aspects such as challenges in the design and management of hybrid renewable energy systems, as well as the main methodologies and techniques for optimizing these systems. Also, most cited articles were published in the top ten of the most relevant magazines: six in “Renewable Sustainable Energy Reviews”, one in “Renewable Energy” and two in the magazine “Solar Energy”. These works correspond to 22% of the total citations present in the analyzed base, which denotes their relevance and their impact for research in the area.

### **3.2 Science Mapping Analysis**

For the analysis of science mapping on Optimization of Hybrid Renewable Energy Systems, the diagrams of co-authorship, co-citation and co-occurrence of keywords developed by the VOSviewer software are presented.

#### **3.2.1 Co-author network per country**

Using VOSviewer software, the cooperation network between countries was created for the production of articles about the Optimization of Hybrid Renewable Energy Systems. This network refers to co-author, where researchers, research institutions, or countries are linked to each other based on the number of publications that are author filiated/written (Pauna et al. 2019). Academic cooperation between countries is significant, as communication between them improves understanding of the topic and the search for innovative solutions, as well as the exchange of experiences through international cooperation (Gao et al. 2016). Considering the 72 countries that have contributed to the study topic, 27 registered, leastwise, five publications on the theme linked in a network or map shown in Figure 5. Also, the size of the circles represents the number of publications, and the thickness of the links represents the strength of collaboration and colors represent collaboration clusters (Van Nunen et al. 2018).

As Figure 5 shows, the three most representative groups correspond to those developed around the United States (red cluster), Malaysia (green cluster) and China (blue cluster) with 10, 7 and 5 member countries respectively, with two clusters identified as smaller ones around Turkey and Iran. We found out that different clusters are formed around the most productive countries in terms of publication production

(Zheng et al. 2016). As noted, the countries that have the most cooperation, in terms of publications with other countries, are the United States and China, with a total of 12 links each. According to the consistency of the collaborations, the most representative is Saudi Arabia with Egypt, China with Egypt, and Malaysia with Nigeria, constituting a total of articles published in co-authorship of 10, 7, and 6 respectively. Despite India being the country with the largest number of publications, it shows a less expressive number of collaborations in HRES Optimization studies when compared to other countries with the lowest number of publications. We observed that a wide range of collaboration already exists among many countries. However, it can also be seen that there are still possibilities for the development of exchange and cooperation in this field. For example, in the past 10 years, leading countries such as India have had no cooperation with countries such as Iran, China, the United States, and Malaysia. Iran has also had no cooperation with the United States even though the two stand out in research on the theme. In this sense, research funding agencies, from different countries, must work together to offer more opportunities for joint research, enabling greater transfers of knowledge and technologies.

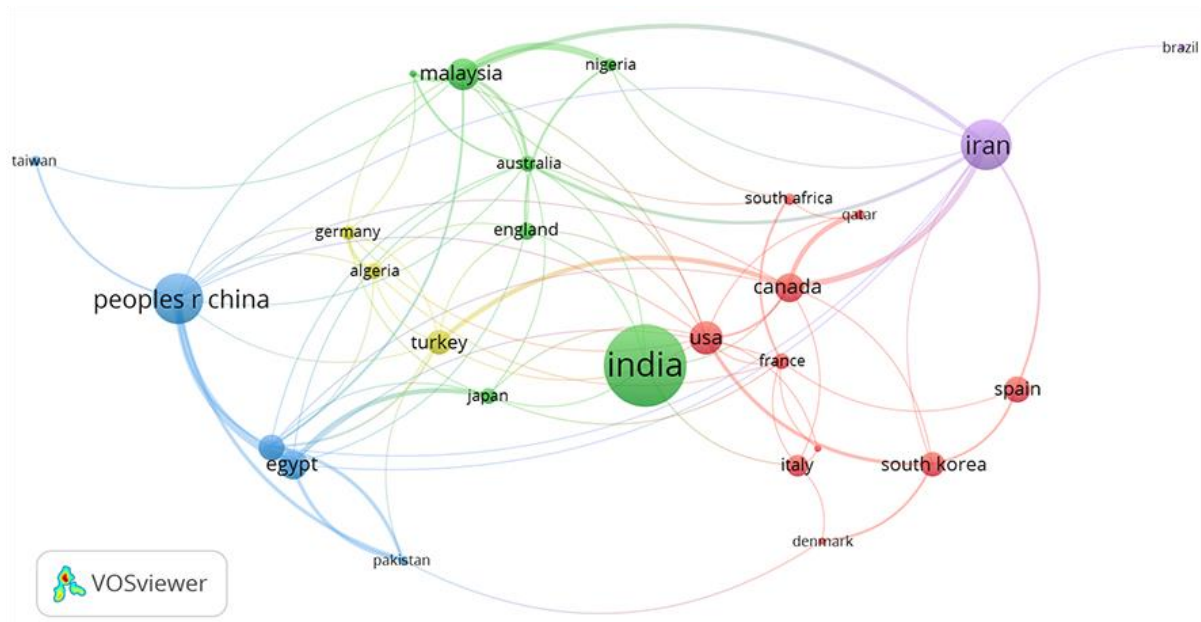


Figure 2. Cooperation network between countries in the production of studies on Optimizing Hybrid Renewable Energy Systems

### 3.2.2 Co-citation network by authors

Analysis of co-citation of authors aims to analyze the intellectual structure of a given area or group of researchers, showing its social, cognitive structure and its research domain (McCain 1990). It can be defined as the analysis of a set of authors structurally organized in a social and cognitive network of a given domain (Grácio and Oliveira 2014).

Figure 6 shows the network of co-citation relationships of authors. The cut-off criterion was a minimum number of twenty citations, which led to a co-citation network of 100 authors (nodes). The size of the circles represents the number of times the author has been cited and the link between two nodes indicates a co-citation relationship, the greater the thickness of the link the greater the frequency of co-citation

between the authors who links and the node color represents the thematic areas that are similar (Fabregat-Aibar et al. 2019).

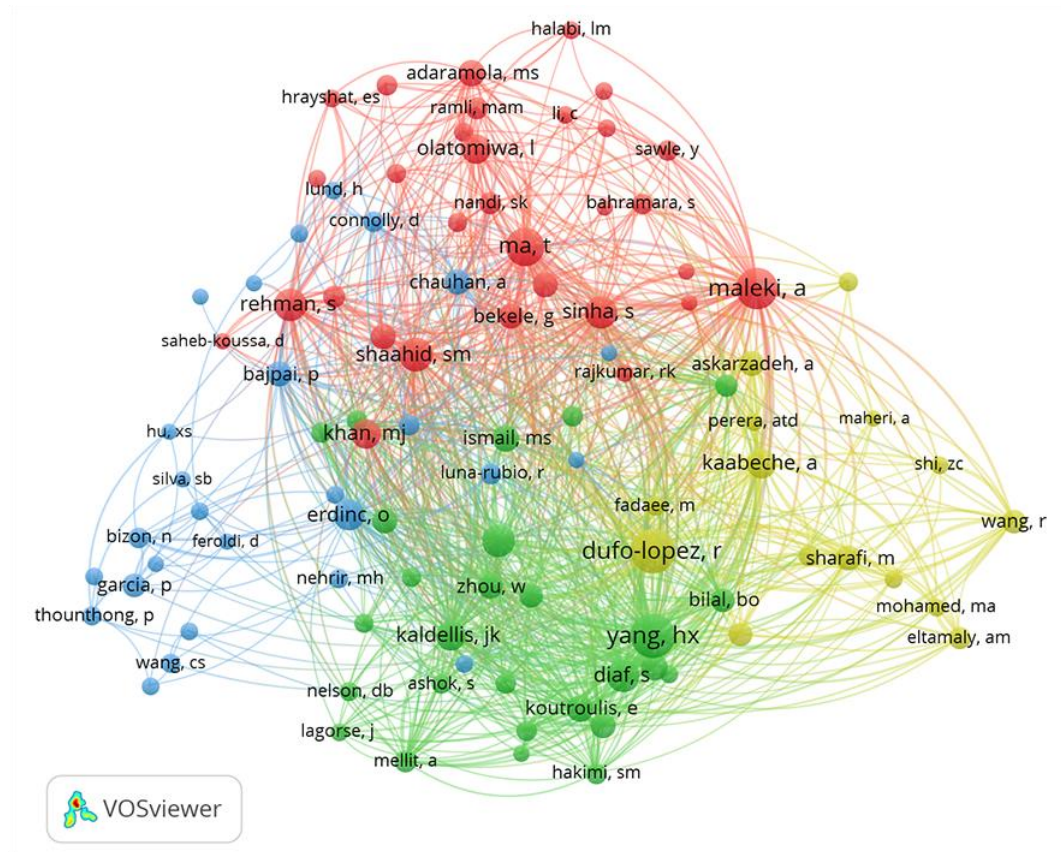


Figure 3. Authors co-citation network

As Figure 6 shows, the co-citation network of authors is distributed in four clusters. The red cluster was the most representative with a total of 31 authors, mainly represented by the group of authors formed by Maleki (120 citations and 2284 total link strength), Ma (108 citations and 1646 total link strength) and Shaahid (82 citations and 1505 total link strength) and the other group of co-authors, including Rehman (79 citations and 1362 total link strength), Shina (77 citations and 1356 total link strength) and Olatomiwa (63 citations and 815 total link strength) link). Using as a reference the studies developed by these researchers, we observed that this cluster mainly concentrates authors who investigate themes related to renewable energy and optimization of the dimensioning and operation of HRES.

The green cluster is composed of 27 authors and has the highest total link strength (23313). The main authors of this cluster are Yang with 140 citations, Bernal-Agustin and Diaf with 78 and 76 citations, respectively. Yang was the author with the highest number of citations and the second with the highest connection strength (2439 the total link strength). Also, Yang has a consistent work with Dufo-López and Kaldellis, with a total of 128 and 76 publications cited together, this can be seen by the thickness of the links. This cluster brings together researchers who show interest in topics related to the control and quality of energy, modeling, and optimization of HRES.

The third cluster (blue) of the co-citations network is formed by 27 authors. The most relevant of them are Erdinc with 72 citations, Bajpai and Chauhan with 49, and 47 citations respectively. The researchers

developed by these authors, taken as a basis for characterizing this group, are predominantly directed to the optimization and control of HRES.

Finally, the yellow set was the smallest with 15 authors, no less important than the other three. This cluster highlights the work of the researcher Dufo-López, who besides being the most cited in the articles sent (145 citations), also appears as the researcher with the greatest total strength of the link (2684), having a co-citation with 96 searches by 100 present in the selection, demonstrating the insertion of his writings in the analyzed field. This researcher is a member of the “Gestión Strategica de la Energia Eléctriaca” research group at the University of Zaragoza, Spain, being one of the first research groups, and perhaps one of the ones with a large number of publications related to multi-objective optimization techniques (based on Genetic Algorithms) for the dimensioning of HRES, in addition to having developed the iHOGA optimization software (Enhanced Hybrid Optimization by Genetics Algorithms), which allows the simulation and optimization of hybrid systems to obtain electricity generation based on renewable energies . In the case of the co-citation relationship between Dufo-López and Bernal-Agustim, it was determined that these were co-cited in a total of 88 publications, in addition to observing the existence of effective collaboration between the authors through co-authorship and because both belong to the same research group.

In general, the great mixture and proximity between the different clusters shows the similarity between the themes researched by the authors. McCain (1990) states that the ACA assumes that researchers, when citing similar and close information sources, address similar research problems in the scientific community to which they belong.

### 3.2.3 Keywords co-occurrence network

This section presents the co-occurrence analysis of the most used keywords in the titles and abstracts of publications. The analysis was performed using the VOSviewer software. For the elaboration of the keywords co-occurrence network, a minimum number of 10 occurrences was defined, with a total of 79 keywords being selected as shown in Figure 7, these being the ones that determine the central theme of a body of documents.



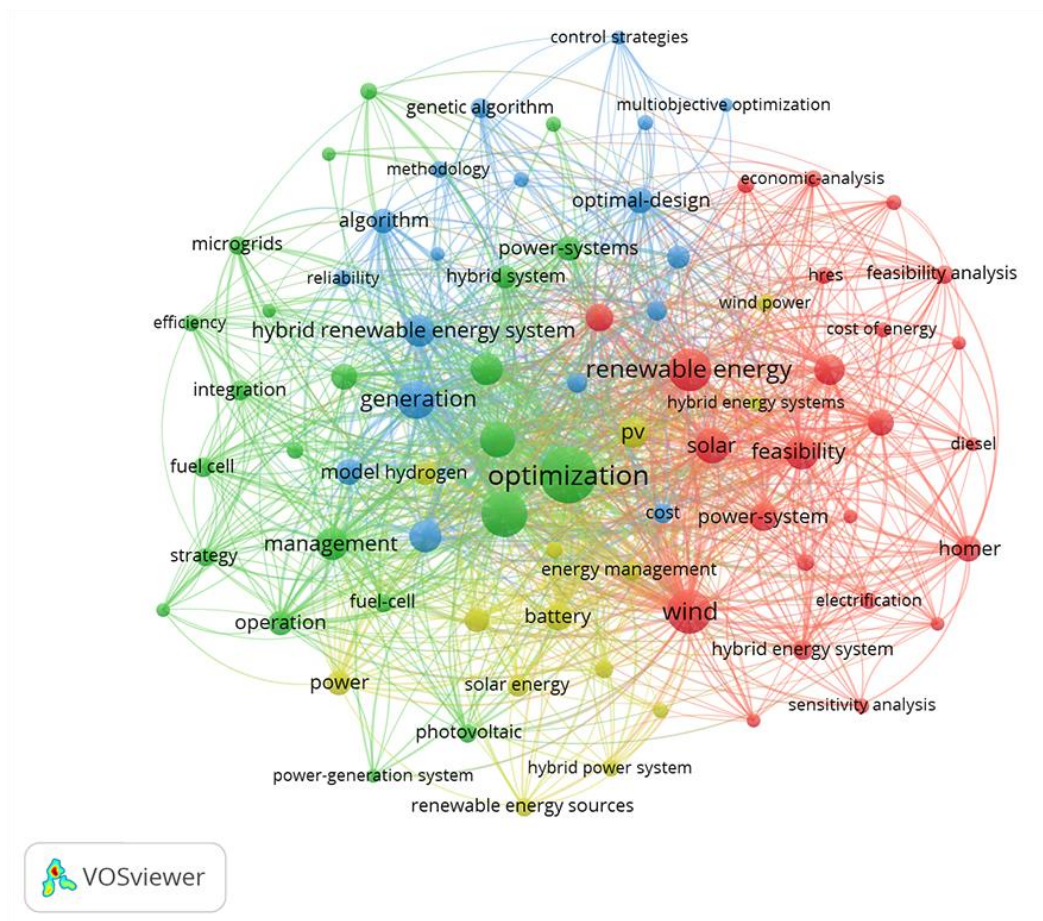


Figure 4. Co-occurrence network of the main keywords

Through Figure 7, the relationship between keywords can be determined. The size of the circles represents the frequency of occurrence of the words, while their proximity indicates the relationship between the research topics, and their relationship is stronger when the distance between them is smaller. The colors are used to distinguish the different clusters (Pauna et al. 2019; Rodrigues et al. 2014; Van Nunen et al. 2018). As shown in the Figure, four main groups of keywords were identified. The yellow subnet is fundamentally concerned with the different energy sources that make up hybrid power generation systems. The blue set focuses mainly on the systems optimization methods and processes. The green group focuses on research related to the characteristics of HRES, while the red group is interested in issues related to economic and financial feasibility analysis.

Table 6 shows the top 10 of the keywords that had the highest occurrence in publications, as well as the total strength of the connections, which are important components of the knowledge structure of scientific production on Optimization of Hybrid Renewable Energy Systems.



Table 6. Top 10 of the most recurring keywords on Optimization of Hybrid Renewable Energy Systems

Keyword	Occurrence	Total strength of the connections
Optimization	152	845
Design	103	567
Wind	96	585
Renewable energy	87	428
Generation	73	402
Storage	63	387
Solar	63	382
Feasibility	56	338
Management	53	312
Performance	53	279

As shown in Table 6 and Figure 7, the keywords with the highest occurrence have their greatest strength in the connections with other words. As expected, the word “optimization” showed the highest occurrence and strength of connection, while the “design” proved to be the second word with the highest level of occurrence followed by “wind”. Figure 6 shows that words like “optimization”, “design” and “storage” have a strong relationship and this can be seen by the proximity between their nodes. These topics are also becoming increasingly relevant and can be verified by increasing the number of publications since 2010 on these topics.

The 79 keywords are further classified into five categories according to Gao et al. (2016), where the first two categories deal with research subjects related to HRES Optimization, divided into types of energy source (Subject 1) and types of electricity market (Subject 2), the other categories are methods, purposes and research field. This analysis aims to identify the relevant keywords for each category as shown in Figure 8 and to facilitate the study, keywords with the same meaning were considered as one.

In the category of types of energy source (Subject 1), “wind” and “solar” are the most important issues with an appearance percentage of 37,2% and 30,0% respectively. In the category corresponding to types of electricity market (Subject 2) the most representative word was “hybrid renewable energy system” with 36,4% of appearance. The third category referring to methods, the keyword “optimization” was the most relevant with 45,1% of appearance within the category. The use of optimization techniques in the development of hybrid energy systems, enable the productive and efficient use of renewable energy resources. According to Tezer et al. (2017) among the meta-heuristic solutions found in the literature for solving HRES optimization problems, genetic algorithms, evolutionary algorithms and particle swarm optimization algorithms stand out, in addition to the use of the HOMER software used for both simulation and optimization of HRES. Considered the latter as a powerful tool for the design and planning of HRES, in order to determine the ideal size of its components through technical-economic analysis (Bahramara et al. 2016). In general, Figure 8 shows the most popular methods found in the literature related to HRES optimization so that researchers can better identify the most useful ones. In the purpose of the research, the most relevant words were “technoeconomic analysis”, “management” and “performance” with percentages of occurrences of 27,3%, 16,0% and 13,6% respectively (see Figure 8).

In the research field category, the most important in terms of occurrence were “design” followed by “renewable energy” and “storage” with the appearance of 24,8%, 20,9% and 15,1% respectively, as shown in Figure 8. The dimensioning HRES is generally done using optimization techniques. These systems, when correctly sized, have a lower cost of generated energy, greater reliability in the supply of energy, in addition to environmental benefits, compared to systems based on a single renewable source (Luna-Rubio et al. 2012). However, the optimal dimensioning of this type of system presents itself as a complex task, which is why it has become a topic of interest to so many researchers, for example (Maheri 2014; Maleki et al. 2016; Wang et al. 2017; Zhang et al. 2013). Several of the works that address the theme of Optimization of Hybrid Renewable Energy Systems consider solar photovoltaic (PV) and wind (WT) generation as the main sources of renewable energy and use batteries as energy storage technology. The use of energy storage resources is taken into account as a complementary component for the optimal design of a HRES, and the integration of this component with sources of solar and wind generation can lead to a flexible and reliable design, whenever the model is well designed for cost effective system operation (Maatallah et al. 2016).

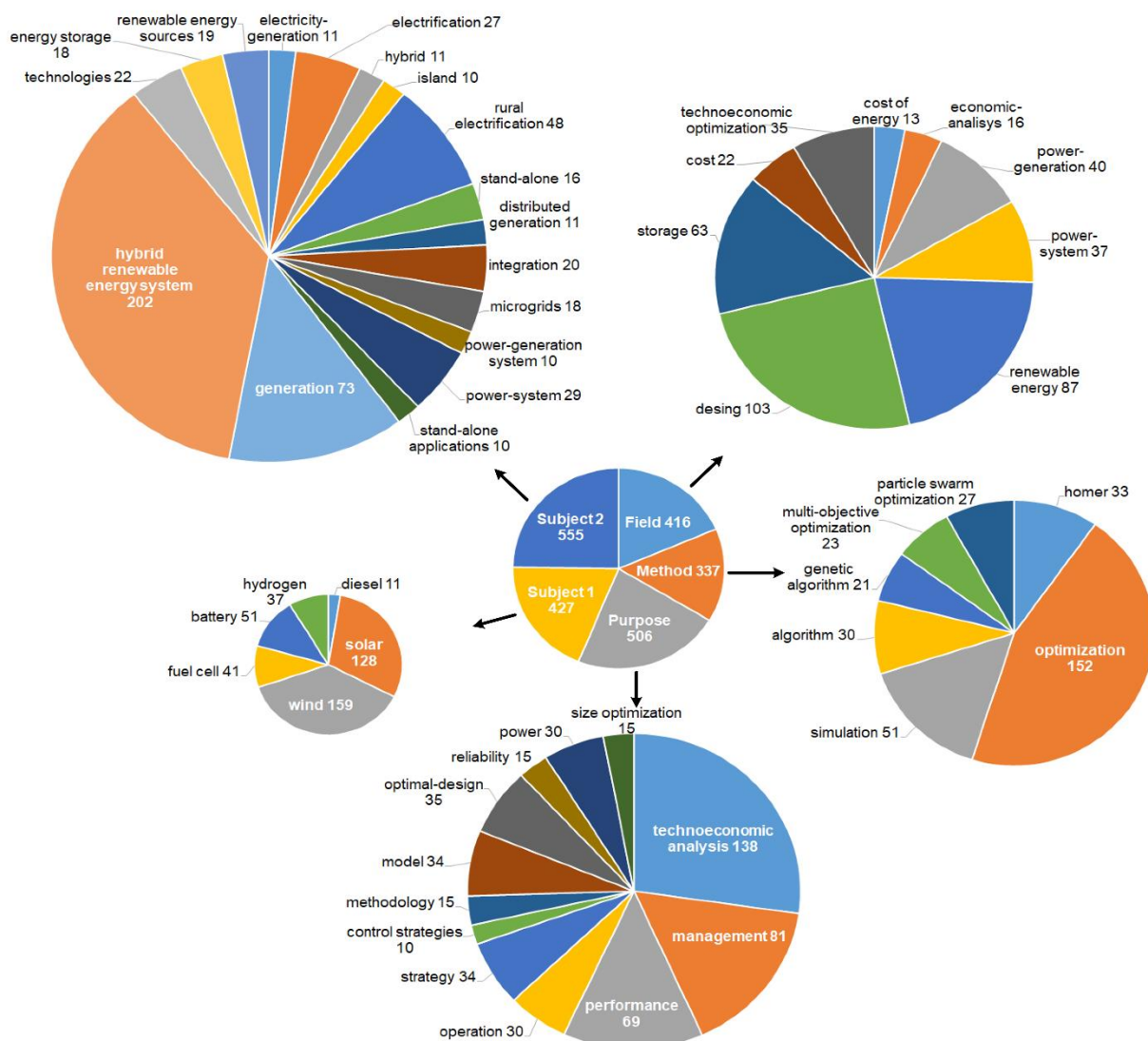


Figure 5. Distribution of keywords by categories

## 4. Conclusion

This study investigated the evolution of research regarding the Optimization of Hybrid Renewable Energy Systems between the years 2010 and 2020 through bibliometric analysis. Based on the Web of Science database, a total of 439 records related to the topic were obtained. Among them, 389 research articles representing 89% of the total publications. English was the dominant language with 438 records. Publications on the subject have shown a growth profile over the years, which may be related to the development of renewable energies and incentive actions for their greater use. India was the leading country in terms of number of publications with a total of 69 records showing the country's interest in this topic. Among the institutions analysed, University Malaya stands out with the largest number of published papers on the subject with a total of 14.

In the analysis of the publications, it was found that “Energy and Fuel” was the most comprehensive category, which highlights the importance of Optimizing Hybrid Renewable Energy Systems for more efficient generation of energy. The most outstanding authors in a number of scientific productions were Eltamaly Ali, Mekhilef Saad, Olatomiwa Lanre and Jurado Francisco with 7 records each. According to the survey, the articles were published in a total of 123 different journals, indicating that this field has been studied under diverse themes and from various perspectives. The magazines “Renewable Sustainable Energy Reviews” and “Renewable Energy” presented the largest number of publications. The most cited article was “A Review of Hybrid Renewable/Alternative Energy Systems for Electric Power Generation: Configurations, Control, and Applications” published in 2011 and has been cited 351 times, with 35 citations annually.

This study also showed from the science mapping that the United States and the People's Republic of China have played an outstanding role in the cooperation network of the 72 productive countries with 12 connections each, however, it was found that there are still possibilities for development exchange and cooperation in this field. Regarding the analysis of the co-citation network of authors, we can say that most of the authors who are important in terms of citations and total link strength have turned out to be the majority of influential authors in the research field, led by Dufo-López, a researcher at university of Zaragoza Spain having 145 citations and co-citations with 96 researchers from the 100 present in the selection, demonstrating the insertion of his writings in the analyzed field, fundamentally addressing themes related to the optimization techniques for the dimensioning of HRES.

An analysis of the co-occurrence network of keywords revealed that “optimization”, “design” and “wind” were the highest co-occurrence index, with a strong link between “optimization”, “design” and “storage”, which are becoming more and more relevant considering the sufficient range of optimization methods, the existence of variations in technologies and energy systems in HRES, as well as the use of storage resources as a guarantee of greater confidence in these systems. Through the classification of keywords by categories it was found that in the method category, a word “optimization” was the most representative, identifying some of the most popular methods in the literature used to solve HRES optimization problems such as genetic algorithms, algorithms optimization by particle swarm and the use of the HOMER software, enabling the identification and greater use of these by researchers in the area.

The results show the value of bibliometric analysis in the evaluation and quantification of scientific production on Optimization of Hybrid Renewable Energy Systems. In this way, this study provides a useful reference for researchers in the field.

## 5. Acknowledgement

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## **Cell death and its relationship to viral infections: What are the ways to fight viruses?**

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**Abstract**

*Cell death is a crucial process for maintaining homeostasis and the development of the organism. They are mainly characterized by apoptosis, necrosis and autophagy, being complex processes and essences for the immune system and balance of the human organism, especially when there are infectious agents such as viruses. Therefore, a bibliographic review was carried out seeking to deepen the knowledge of cell death applied to viruses, and its possible action against COVID-19, demonstrating the action and importance of understanding and understanding cell death pathways and applying their results as therapeutic targets. The results obtained showed the individual action of cell deaths against the virus in the immune system and emphasized the understanding of cell death pathways as fundamental for the development of drugs and therapies for viral control for already known viruses and for new viruses, such as Covid -19.*

**Keywords:** Apoptosis; Necrosis; Autophagy; Virus;

**Introduction**

Cell death is an essential biological element for the process of physiological growth and development of the organism (CHEN; KANG; FU, 2018). There are three classic forms of cell death: apoptosis, autophagy and necrosis, which define the response of the surrounding cells and organs in response to impulse, thus maintaining the organism's homeostasis (MESSNER et al., 2016).

Cell death can be programmed or accidental, programmed cell death results in lytic processes or non-lytic morphology, depending on the signaling pathway involved (JORGENSEN; RAYAMAJHI; MIAO, 2017). Among the classic types of cell death, two are programmed, namely, apoptosis and necrosis (ZIMMERMANN; GREEN, 2001). The autophagy consist a physiological process of the cell, in the form of self-degradation of cellular components in response to extracellular changes and intracellular stress (HE;

KLIONSKY, 2009). Figure 1 illustrates the types of cell death and their morphological characteristics mentioned (NIKOLETOPOULOU et al., 2013).

Apoptosis is a cellular process that directs the cell to cellular suicide, following two major pathways: mitochondrial or activation of the death receptor (AGNELLO et al., 2015).

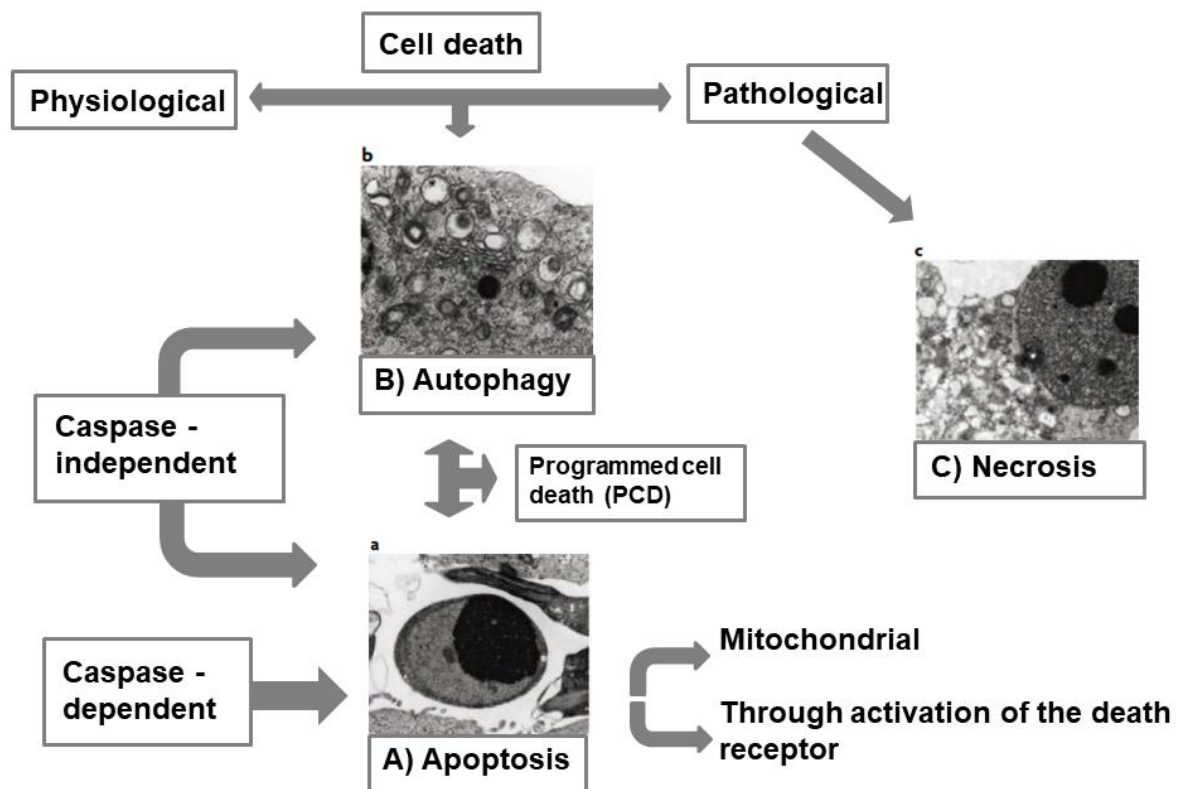
The death receptor activation pathway is called the extrinsic pathway, and depends on the interaction of cell death receptors, such as the Fas receptor (FasR) and Fas ligand (FasL) (BERGANTINI et al., 2005). While the mitochondrial pathway, also called the intrinsic pathway, is triggered mainly by non-receptor stimuli, including deprivation of cytokines, DNA damage and cytotoxic stress, but it can also be activated by death receptors (SHIOZAKI; CHAI; SHI, 2002).

In order for apoptosis to occur, the caspase pathways are activated, which are inactive proteases and present in practically all animal cells; these biochemical cascades are activated in cells destined for apoptosis (GARRIDO; KROEMER, 2004). The caspases minimize damage and destruction to neighboring cells, in addition to preventing the release of immunostimulatory molecules, making the process restricted to the injured cell (TAYLOR; CULLEN; MARTIN, 2008). In sequence after the programmed death is triggered, the apoptotic cell quickly disappears from the tissue without generating an inflammation, as they are digested by the phagosome without causing an inflammatory response in the body. (BRASS, 1997).

Necrosis is a pathological cell death process that can be induced by ligands that bind to the specific plasma membrane, by receptors, genetic regulation, epigenetics, and pharmacological factors (QUEIROZ et al., 2020). In it, granulation of the cytoplasm and cell swelling occurs, which results in the rupture of the plasma membrane and the organelle, causing leakage of the intracellular content due to physical damage to the cell (KIM-CAMPBELL; GOMEZ; BAYIR, 2017).

Therefore, the host cell death has been demonstrated in several cases of viral infections, since these microorganisms, especially viruses, can trigger the cell death process (LABBÉ; SALEH, 2008). In addition, in viral infections such as that caused by COVID-19, there are no specific drug treatments so far (KHEDKAR; PATZAK, 2020), understanding the pathways of cell death can serve as promising options for the development of treatment (FAKHRI et al., 2020a).

Therefore, understanding the functioning of cell deaths can help in the treatment, or even the knowledge of disease control and etiology.



**Figure 1:** Mechanisms of necrosis, apoptosis and autophagy showing a diagrammatic of the different types of cell death. PCD: programmed cell death. Morphological characteristics of a) apoptotic cell b) an autophagic cell, c) a necrotic cell. (Electromicrograph images adapted from KROEMER et al., 2008. Scale bar: 1 mm) (KROEMER; LEVINE, 2008).

## Materials and methods

The present study corresponded to an integrative literature review, carried out from March to October 2020. For this purpose, the articles were searched in the Google Scholar, SciELO and PUBMED databases. To search for content in the described databases, Research in banks of data was performed using “Cell death” as the central theme and with subdivisions: “Cell death in viroses”. The articles were based on descriptors created by the Virtual Health Library developed (<http://decs.bvs.br/homepage.htm>) from MeSH - Medical Subject Headings of the US National Library of Medicine (NLM), which allows the terminology in common in Portuguese, English and Spanish. The descriptors were: Cell Death; Virus.

To complement the database, a manual search of references was also carried out to identify eligible studies. The inclusion criteria for the articles selected for this research were: “Articles published in journals indexed in the databases mentioned above”; “Articles published in Portuguese, English or Spanish”; “Articles published in the period from 2005 to 2020”. In this sense, no restrictions were applied to the sample of studies and articles not related to the descriptors of the pre-established theme were excluded.

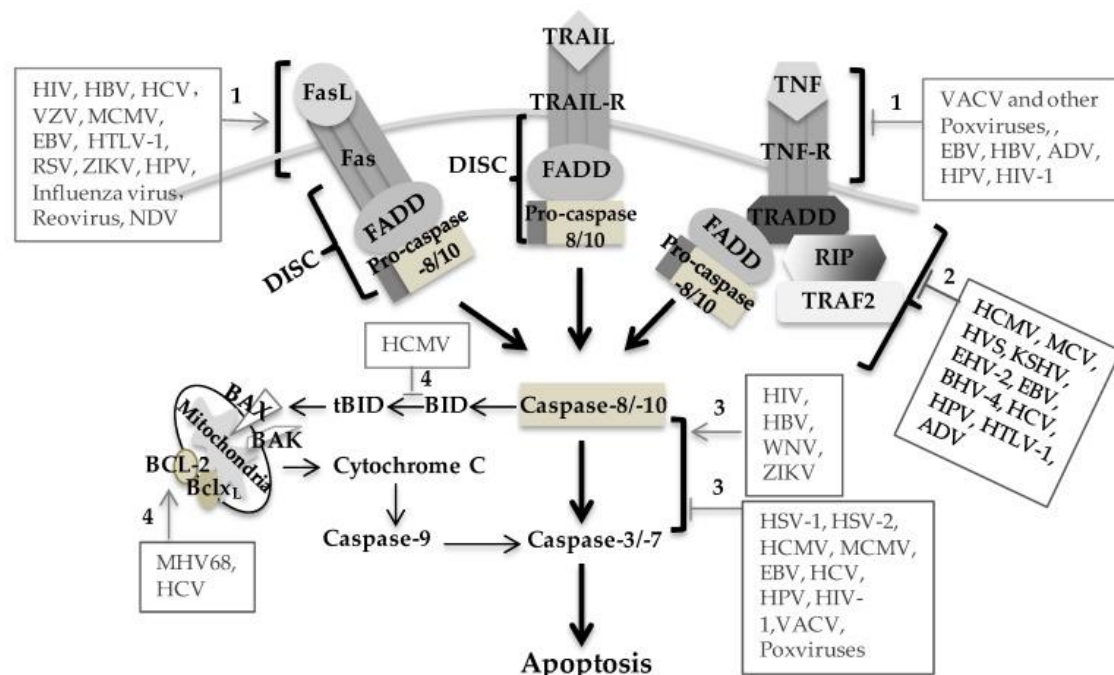


## Results and discussion

### *Cell death caused by microorganisms: Pathways of cell death activation by viroses*

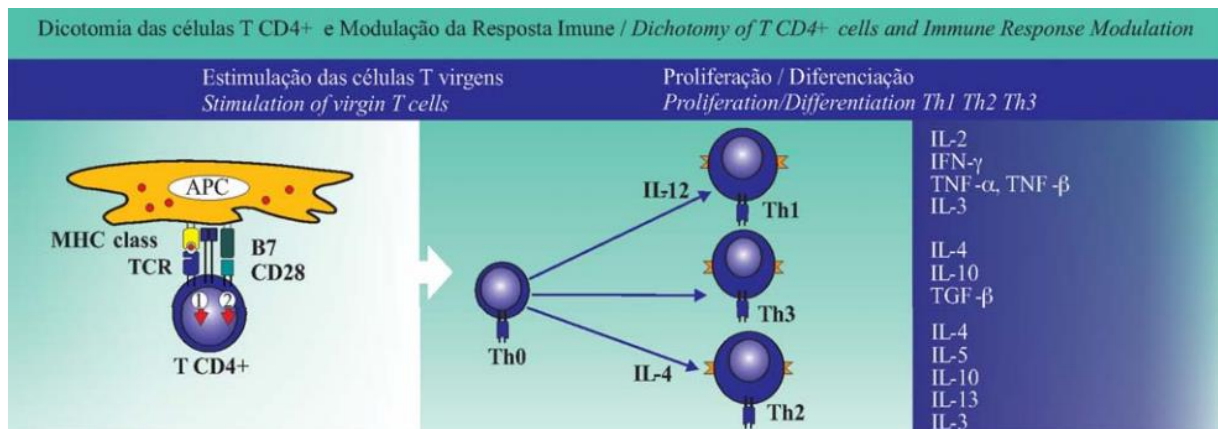
In viral infections, for an infected cell to be eliminated from the body, it needs to be phagocyte (NAINU; SHIRATSUCHI; NAKANISHI, 2017). For this to occur, apoptosis of infected cells must occur allowing the elimination of viruses as an innate immune response (NAINU; SHIRATSUCHI; NAKANISHI, 2017). Still, according to the author, this mechanism is effective against most types of viruses and seems to be conserved among multicellular organisms (NAINU; SHIRATSUCHI; NAKANISHI, 2017). Based on this precept, the induction of cell death by apoptosis contributes to the cytopathic effects of viral infection, and its morphological characteristics are frequently observed in cells that suffer direct viral cytotoxicity, as in the case of the new corona virus and Human Immunodeficiency Virus infection 1 (HIV-1) (CHEN et al., 2020a; PATEL; GORES, 1998; SILVA, 2016).

This is because the initial response to viral infection starts from the innate response of immunity through the death of virus-infected cells, mediated by cytotoxic T lymphocytes and natural killer cells (BARBER, 2001; PAROLIN; MESSIAS REASON, 2001). Figure 2 shows the viral modulation of apoptosis due to death receptors caused by viral infection (ZHOU et al., 2017). The second host defense-mediated response is also triggered, involving the induction of a family of cytokines known as interferons (IFNs), which are essential to initiate and coordinate a successful antiviral response (CHAWLA-SARKAR et al., 2003). These molecules stimulate adaptive immunity through cytotoxic T cells and induce a series of intracellular genes that directly prevents virus replication and cytolysis, thus favoring apoptosis (BARBER, 2001). Figure 3 demonstrate how viruses are destroyed through innate immune response. In the initial phase of viral infections, these infections are controlled by type I interferons (IFN- $\alpha$  and IFN- $\beta$ ), macrophages and Natural Killer cells (NK)(MACHADO et al., 2004).



**Figure 2:** Viral modulation of apoptosis mediated by death receptor. The death receptors Fas, TRAIL-R and TNF-R form DISC by binding to their ligands, activate a cascade of caspases and subsequently initiate extrinsic apoptosis. Activation of caspase-8 can cleave BID into tBID and bind to the mitochondria-

mediated intrinsic apoptosis pathway. A virus infection regulates a death receptor-mediated extrinsic apoptosis, mainly by means of virus-encoded proteins. Regulatory ones involve: (1) an expression and function of regular receptors / death ligands; (2) interfere with the formation and function of the DISC; (3) regulation of caspase activities; (4) regulation of the expression and function of pro-apoptotic and anti-apoptotic proteins. A black arrow represents a signal induction; the gray arrow represents the virus-induced signal; the gray T bar represents the signal inhibited by viruses (ZHOU et al., 2017).



**Figure 3:** Mechanisms of antiviral activity of innate immunity (MACHADO et al., 2004).

These factors occur because the main death effect or mechanism of cells infected by the virus is mediated by cytotoxic T lymphocytes and "natural killer" cells, being then guides to the extrinsic pathway of apoptosis, which, through the death of the infected cell, prevents the spread of the virus (PAROLIN; MESSIAS REASON, 2001). The extrinsic pathway is dependent on the binding of ligands (TNF, FasL) to their death domain receptors present in the plasma membrane, when the cell is infected by a virus (PATEL; GORES, 1998; QUEIROZ et al., 2020). In this case, death receptor-mediated apoptosis represents an efficient mechanism by which the virus can induce cell death and spread the progeny, which plays an important role in viral pathogenesis and provides a potential therapeutic target.

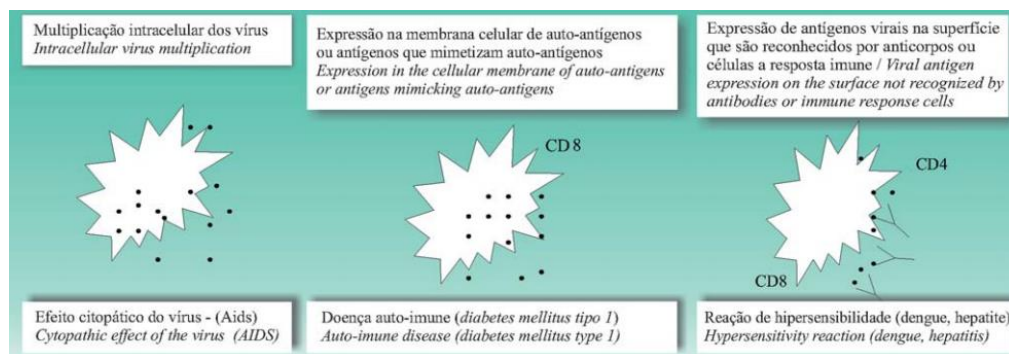
In the case of autophagy, like apoptosis, it can work with antiviral ability to suppress virus infection (AHMAD; MOSTOWY; SANCHO-SHIMIZU, 2018; DELORME-AXFORD; KLIONSKY, 2020; QUEIROZ et al., 2020). However, some viruses can usurp and exploit autophagy machinery to support replication (AHMAD; MOSTOWY; SANCHO-SHIMIZU, 2018). In addition, selective autophagy controls several human viral infections in vitro, leading to the elimination of viral pathogens or antigens and the survival of the host cell. The study by AHMAD *et al.*, Demonstrated that autophagy plays an important role in the control of cytokines in HIV-1 infections and influenza A virus (IAV) infection, allowing studies to prevent prolonged and excessive inflammation harmful to the host caused by these viroses (AHMAD; MOSTOWY; SANCHO-SHIMIZU, 2018). Such facts, allow to investigating the control of viral infections, and to formulate new therapeutic options for treatment.

#### *Viral infection and tissue damage:*

Viruses are capable of inducing apoptosis and necrosis of various types of cells after they enter the host, including T cells, endothelial and epithelial cells; through vascular leakage mediated by pro-

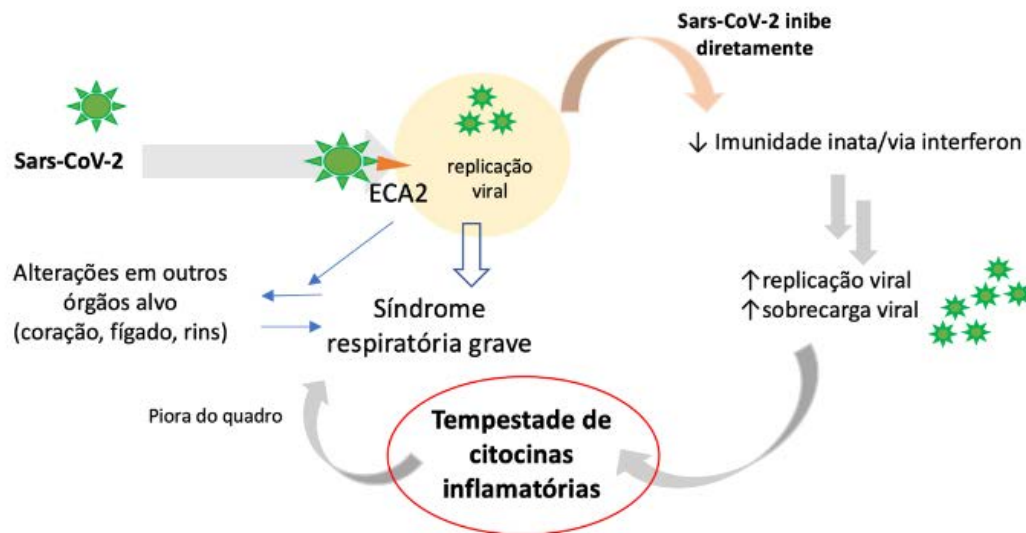
inflammatory cytokines and chemokines and T cell responses (MACHADO et al., 2004). According to the same authors, in many of these situations there is a hypersensitivity reaction with an exaggerated and unmodulated immune response those results in tissue damage due to the cytopathic effect of the virus, hypersensitivity reaction and autoimmune phenomena (MACHADO et al., 2004). This leads to the protective immune response to a weakened state, which allows the virus to spread and promote massive tissue destruction (SHI et al., 2020).

Consequently, damaged cells induce innate inflammation that is largely mediated by pro-inflammatory macrophages and granulocytes, as well as the release of reactive oxygen species and proteases (MIMS; NASH; STEPHEN, 2001). These defense cells, when attempting to destroy the virus, will cause mass destruction of all surrounding alveolar cells, which may cause anoxia or necrosis in the tissues irrigated by these vessels (MIMS; NASH; STEPHEN, 2001; SHI et al., 2020). The figure 4 shows how these pathologies associated with viral infection may be related to the cytopathic effects of the virus, hypersensitivity reaction and autoimmune phenomena (MACHADO et al., 2004).



**Figure 4:** Effects of pathologies associated with viral infections on cells (MACHADO et al., 2004).

In the case of COVID-19 infection, according to Liu et al., The interaction between virus and host cell occurs through the ACE2 protein, found in a variety of organs such as the lungs and liver (LIU et al., 2020). From this connection, damaged cells induce innate inflammation in the organs with a higher incidence of ACE2, through a cytokine storm mediated by pro-inflammatory macrophages and granulocytes, promoting tissue damage (SHI et al., 2020; ZHANG; SHI; WANG, 2020). Figure 5 shows the cytokine storm produced by Sars-cov-2, where the virus inhibits innate immunity via interferon, increasing the viral load, which causes the cytokine storm, worsening the patient's general condition (ANTONIO et al., 2020).



**Figure 5:** SARS-CoV-2 infection and cytokine storm production. The virus fuses into the host cell by recognizing the ECA2 receptor, which releases its genetic material for viral replication. During this process, the virus inhibits innate immunity via interferon, increasing the viral load, which causes the cytokine storm, aggravating the patient's general condition (ANTONIO et al., 2020).

Terpos *et al.* demonstrated that lymphocytes express the ACE2 receptor on their surface, so SARS-CoV-2 can directly infect these cells and ultimately lead to their lysis. This cellular damage characterizes cell death and tissue degradation (TERPOS et al., 2020).

In addition, according to the same authors, the cytokine storm is characterized by markedly increased levels of interleukins and tumor necrosis factors alpha (TNF-alpha), which can promote lymphocyte apoptosis, impairing the defense against the virus and increasing tissue damage (TERPOS et al., 2020).

Furthermore, studies of FAKHRI *et al.* 2020 emphasize the crucial role of oxidative stress, inflammation, apoptosis, autophagy, in triggering the pathogenesis and complications of COVID – 19 (FAKHRI et al., 2020a). What emphasizes the need to understand the pathways of cell death so that there is the development of drugs that control the progress of the infection, as shown in the study by FAKHRI et al., 2020 which, through the study of the steroid astaxanthin, sought to deregulate the autophagy harmful to the organism and apoptosis reduction contain the inflammatory complications of COVID-19 (FAKHRI et al., 2020b).

The same occurs in studies to control Ebola, which in addition to the disturbance of the immune system, infects vital organs, such as the liver, spleen and kidneys, where it kills the cells that regulate coagulation, chemical and fluid homeostasis and responsiveness. Immunological (JACOB et al., 2020). In this case, for IBA *et al.*, 2020, finding drugs that can regulate apoptosis would be essential to help control infection (IBA et al., 2020).

#### *Cell death and the relationship with Covid-19*

SARS-CoV-2, or Covid-19, has been manifesting since December 2019, causing a pandemic, and generating symptoms since mild, such as cough and loss of taste and smell, as severe, as lymphopenia and



severe acute respiratory syndrome (CHEN et al., 2020b; RODRIGUEZ-MORALES et al., 2020; ZHENG, 2020). Studies indicate that contamination with this agent can cause prolonged cytokine and chemokine responses, resulting in immune defects and the death of some patients (TAGHILOO et al., 2020).

Feldmann *et al.* (FELDMANN et al., 2020) suggested an anti-TNF therapy applied to patients with COVID-19 on hospital admission to prevent progression to the need for intensive care support, aimed at reducing inflammation. As well as the study of drugs aimed at the proliferation of lymphocytes through inhibition of apoptosis, such as corticosteroids (WALSH; SEXTON; BLAYLOCK, 2003), can inhibit a lymphopenia and also compensate the lymphocyte count in critically ill patients with this viral disease, increasing immunity and a chance of cure for these patients (FATHI; REZAEI, 2020).

Among the studies on drugs and the complications caused by SARS-CoV-2, studies on FAKHRI *et al.*, 2020 claim that oxidative stress, inflammation, interference with apoptosis and autophagy, are responsible for the pathogenesis and complications of COVID-19. These authors seek the development of drugs with a potential anti-inflammatory, antioxidant and anti-apoptotic effects, as well as the modulation of autophagy (FAKHRI et al., 2020a).

In addition, the literature states that manipulations of the response to cell stress induced by coronavirus due to the cytokine storm could be a powerful approach in combating the pathogenesis of COVID-19 in patients with severe pneumonia or multiple organ failure (HAMMOCK et al., 2020).

COVID-19 causes severe acute respiratory syndrome as a complication in some patients (RODRIGUEZ-MORALES et al., 2020). Guler *et al.*, al (GULER; SIDDIQUI; FAREED, 2020) show that the relationship between COVID-19 and apoptotic pathways contributes to the focal pathogenesis observed in the lungs and is involved in the progression of the severity of this complication. This, according to the authors, occurs due to the increase in D-dimer in view of the apoptotic processes that target the endothelial cells of the vascular structure, resulting in triggered coagulopathy and in the final result of the increased D-dimer, which increases the rate of mortality of infected patients.

Therefore, the understanding of cell death pathways and their action against the viral agent and in the immune system allows the development of drugs that use the modulation of cell death processes as a defense tool of the host organism and tissues against viral infections and their possible complications.

## Conclusion

With the bibliographic survey presented, it was possible to conclude that cell death is fundamental for the maintenance of the organism's homeostasis, since it defines the cellular response caused when there is an imbalance in the extracellular and intracellular media. In the case of cell death caused by viral pathogens, the literature states that this bioprocess acts to block the progress of these diseases, and to contribute to the development of drugs, since their pathways are used as regulatory instruments that act against the viral agent and help the immune response. Thus, we can conclude that scientific knowledge of cell deaths due to apoptosis, necrosis and autophagy, are necessary for future studies in the treatment and control of pathologies, allowing the study and development of drugs and therapies to control existing, future and perhaps even pathologies cure current illnesses like COVID-19.

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# **Bioecological Theory and Risk Management: A Model for School Risk Planning**

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## **Abstract**

*With the vulnerability, unpredictability, and ambiguity of the situation, schools all over the world have faced a variety of restrictions and unprecedented risks that caused some to cease operations and classes permanently or for an extended period of time. The concept of risk has become closely associated with every school process and structure so as to aid them in adapting to the current situation. This paper explores the concept of risk management and risks planning through the lens of school management and the Plan-Do-Check-Act (PDCA) Cycle. Furthermore, the researchers link the permeation of the direct and indirect effects of risks in the school system by reflecting on the layers of the school's bioecological nest as adapted from the Bioecological Theory of Urie Bronfenbrenner. Finally, this paper suggests a model for risk planning that can help school administrators and leaders in managing risks and aid future researchers in studying concepts related to risk management.*

**Key Words:** Bioecological Theory; PDCA Cycle; risk management; school management; systems thinking

## **1. Introduction**

The world is undergoing a drastic health situation involving billions of individual lives. This situation has birthed a cascade of challenges, difficulties, and imparity, and imbalance in an otherwise steady and organized set of planned activities and tasks, in economics, social, environmental, political, educational, and medical fields.

Since the emergence of CoViD- 19 back in December 2019, many other diseases have risen and caused havoc aside from the deadly COVID virus itself. Challenges of societal unpreparedness, medical

disparities, economic and financial depression, political mishaps, and even educational setbacks have come into view. All of these add up together— a great “generational catastrophe” (UN, 2020, p. 10).

The main theme for this year’s situation is about risks and threats. The risky situation of going out and getting infected through close contact and unsafe socialization practice, the threat of family and job loss, and the burden of conscience: to die of hunger or to die of infection, have become the mental frame of the common Filipinos experiencing this generational catastrophe. It has caused them to tread as carefully as possible, with eyes focused on survival.

The same is true for many institutions and organizations around the world. In the Philippines, 15% of businesses have permanently closed, causing a pessimistic and skeptical attitude among the Filipinos as the community lockdown continues to subdue the economy because of the CoViD- 19 threat (OneNews, 2020). This comes in a growing number as more businesses are in decline because of low sales and poor logistics and operations since all are required to operate within the set standard of health protocols, delimiting their regular activities.

Furthermore, in educational businesses, schools have either temporarily or permanently suspended their services. Reportedly, CNN revealed that about 748 private schools have decided to temporarily close and suspend school operations during this time of the pandemic (CNN Philippine Staff, 2020). The risk of operation with fewer student enrollment is a threat to school stability. Due to the devastating effects of the pandemic, a catholic school in Manila has permanently closed (Jazul, 2020). This is a gap that needs to be addressed as it involves a seemingly permeated effect of the pandemic in the environment and society.

Managing risks and threats can become the fundamental life-support of risky schools, those at the point of closing or suspending due to various reasons including the pandemic. Risk management occupies a very important role during these uncertain economic times and can help to address these stressful situations. Risk management takes into account the proactive key steps to reduce or alleviate limiting factors in an organization. Further, it takes into consideration the vision, mission, goals, and objectives of the organization to set the direction in developing sure-fire-target strategies to address a certain threshold. The researchers argue that the role of risk management is often only seen when administrators deal with specific problems in specific instances, not on the layered level targeting the scope of issues. This causes an oversight on other existing risks, in a different environment, which adds to the specific problem.

## **2. Conceptual and Theoretical Frameworks**

### **2.1 Risk and Risk Management**

Bialostok (2015, p. 562) stated that “society is characterized by uncertainty: dangers, hazards, and threats, and a proliferation of risks”. The statement poses several implications: (1) uncertainty is everywhere, (2) people, institutions, and organizations always face uncertainty, and (3) uncertainty comes into many forms. This description captures the complex threshold, the extent of which, and the importance of taking into account the effects and root cause of understanding uncertainty. Further, it also specifies who is involved in the characterization, identification, and assessment, and process of risk management.

As stated, risk and threat is a form of and a way for uncertainties. Šotić & Rajić (2015, p.17) stated that risk is “ a word that causes the feeling of urgency because it addresses detrimental, sometimes catastrophic

outcomes. In another definition, Bialostok (2015) stated that, based on several social and cultural contexts, a risk may be defined as "...a requisite way of understanding contemporary uncertainties and our times" (p. 562). Williams & Heins (1964) defined risk

"...as objective doubt concerning the outcome in a given situation. It is the doubt a person would have concerning the future outcome even if he knew all the possible outcomes and their probability or chance of occurrence" (cited by Crowe & Horn, 1967, p. 460).

From the series of definitions, it can be stated that risk is a perception of the observer on the possibilities and probabilities that a certain threat/opportunity (or situation) can cause a loss or damage, or reward. This definition is supported by Helsloot & Jong (2006) who stated that risk is a social construct that is constructed by actors (p. 144), hence, the identification of risk is dependent on the observer. This calls for an understanding of the process of risk management and understanding the limits caused by threats and opportunities.

The connotative definitions of risk always result in the thinking of negative results and outcomes. However, risk comes in two types, positive and negative risks. Bisson (2014) defined positive risk as taking advantage of the opportunities present while the negative risk is a threat that causes an issue. The two definitions posit the sense of future possibilities depending on the kind of risk, whether an institution can gain or incur a loss. Therefore, in managing risks, one needs to identify key opportunities and threats and make use of them to an advantage.

## ***2.2 Risk Management and the P-D-C-A Cycle***

Going back to the statement of Bialostok (2015) that society is characterized by uncertainty, this means that individuals or groups of individuals such as corporations, institutions, or organizations belonging to the society always face uncertainty, as stated above. This rudimentarily points to the involvement of the direct and indirect parties, as well as the internal and external environment in which the parties are situated. According to Ennouri (2013), identification of risks can help organizations or individuals to favorably and confidently manage risk based on sound decision-making. Ennouri (2013) stated that risk identification is the first step in detecting uncertain events that can upset order in the system. During this pandemic, risk identification helps in proactive management of schools to check the possible routes or directions of policy implementations and operations following the community lockdowns and strict health protocols.

Further, Ennouri (2013) and Srinivas (2019) stated the importance of risk assessment. Srinivas (2019) stated that risk assessment is the stage where the collected and identified risks are analyzed. Additionally, Srinivas (2019) and Ennouri (2013) underpin the fundamental step of forming, developing, and taking corrective actions and categorizing potential impacts of risk to reduce, mitigate, or avoid them. Performing environmental scanning and surveys from school stakeholders and interested parties is a step that, not only identifies risk, can assess the situation to help in sound decision-making strategies.

The next stage is risk response planning (Srinivas, 2019). It involves the adoption of strategies in response to the identified and assessed risks. On the other hand, Ennouri (2013) refers to this stage as another risk management step. Ennouri (2013) stated that it "refers to the selection and implementation of the optimal corrective strategy for the risks identified" (p. 291). This stage, according to the definitions, checks the developed strategies for their suitability and feasibility as they are applied to address different risks within

an institution. In schools during the pandemic, this is seen as the implementation of various instructional, logistical and operational, and service strategies to address the needs of the school. However, it doesn't stop there.

The last stage refers to the risk monitoring and controlling step (Srinivas, 2019; Ennouri, 2013). Ennouri (2013, p. 291) stated that this last stage is "where the system is supervised to measure the efficiency of corrective actions and detect the potential risks not identified in the previous steps, this step can improve the risk management system". Srinivas (2019) identified four strategies to be implemented when facing negative risk: (1) risk avoidance, (2) risk transfer, (3) risk reduction, and (4) risk acceptance; and he also identified key strategies for dealing with positive risks (1) exploit, (2) share, (4) enhance, (5) accept, (6) contingent response strategies and (7) Expert judgment.

The process of risk management involves and touches the Plan-Do-Check-Act cycle. The Plan stage equates to the risk identification where there is a proactive determination of key steps in various risk control mechanisms, its severity and prioritization, and possible treatment. Do stage equates to the risk assessment step where it involves the corrective action phase and risk analysis. Risk analysis calls forth decision-making as a vital step in fighting potential risk along with risk management. Risk and exposure to it is an important concept within an organization (Sevilay & Ömer, 2018). The check stage is the adoption of strategies and implementation to further collect more data and determine if the strategies are successful. Lastly, the Act stage is when the strategies are given in a larger scope if the strategies worked well, or replanning if the strategies didn't conform with proper monitoring and controlling. Since the core of the risk management process is the PDCA cycle, it can be considered that risk management is an iterative process involving the "systematic application of management policies, procedures, and practices to assess and manage risks" (Ennouri, 2013, p. 291).

### 2.3 Risk, Risk Management and Limits to Growth Archetype

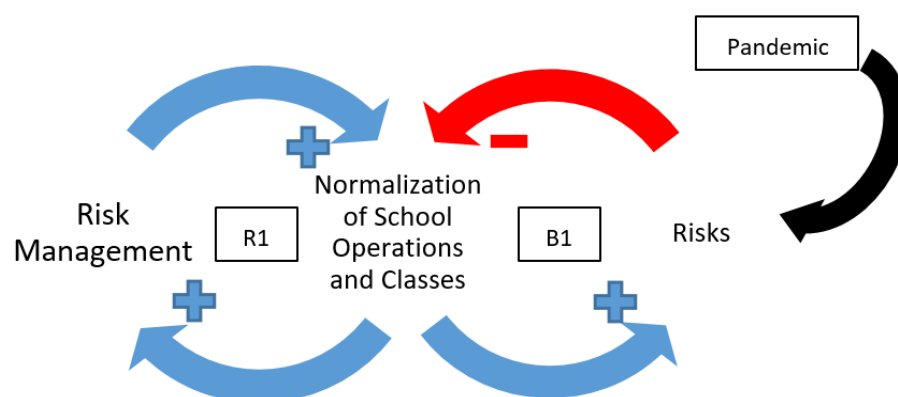


Figure 1. The interaction between risk and risk management, and pandemic as a limit to growth.

According to Braun (2002), limits to growth or limits to success archetype "put forth the premise that growth cannot continue unabated in an unrestricted reinforcing dynamic" (p. 2). This means that growth will also be pushed back by unknown factors, which causes it to be restricted or limited after some time. Limits to growth/success archetype are made up of two loops, the first loop is the Reinforcing Loop, which



represents the growth/success, which is countered by the second loop, the Balancing Loop, which restricts the growth.

Fig. 1 above shows the interaction between risk and risk management and pandemic in the lens of limit to growth archetype. The school, to achieve continuous growth and success, will continuously employ strategies and managerial techniques. This process is causal in line with the balancing loop seen as the day-to-day risks a school experiences. However, due to the drastic explosion of infection of CoViD-19, the continuing efforts of risk management are disrupted because of its scale, cascade of implications, and other mitigating factors that influence the loop. As the school approaches its limit, one may find it hard to maintain the balance again, hence as school closure, either temporarily or permanently (as seen in the case of a catholic school in the Philippines), is the last end. This is seen as a collapse in the system. This calls for a proactive risk planning of the unknown, planning for the limit. It is obvious that many schools have experienced a shock in their operations and classes because of unpreparedness and lack of foresight in risk and risk management. Braun (2002) stated that “If we don’t plan for limits, we are planning for failure” (p. 3). This calls for a holistic risk management model that does not target day-to-day risk, opportunities, and threats, but something that is applicable in immediate, abrupt, and large scale issues.

#### ***2.4 Risks, Limits to Growth Archetype and Bronfenbrenner’s Bioecological Theory***

Reflecting on the idea that risk can be seen internally and externally (Crowe & Horn, 1967; Aven, 2016), it can be said that a school’s way to deal with risk and limitations cascades from within to its immediate surroundings and environment. Additionally, reflecting on the idea that schools develop and improve over time like a person, the researchers integrated the concept of Bronfenbrenner’s Bioecological Theory as a unifying concept for the model.

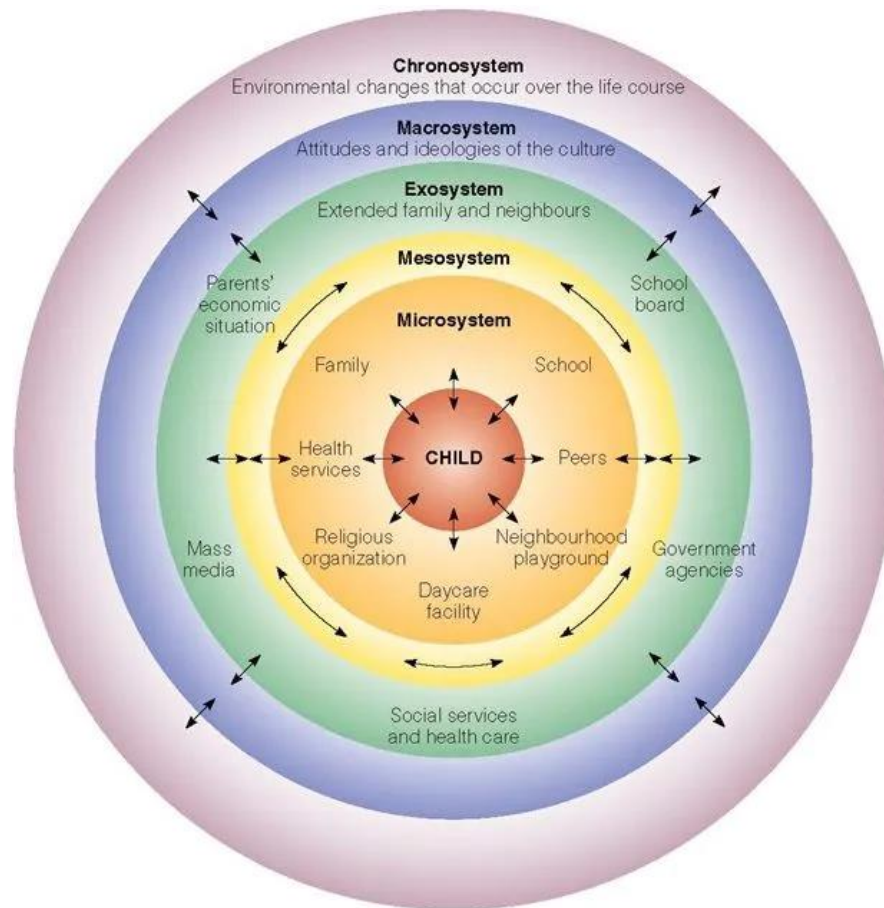


Figure 2. The five Bioecological System as described and viewed by Guy-Evans (2020) in a child's environment.

Bronfenbrenner's Bioecological Theory posits the effects of a person's environment on his/her growth and development, the conditions and process involved within the nested system (Ashiabi & O'Neal, 2015; Guy-Evans, 2020). This nested system refers to the (1) Microsystem, (2) Mesosystem, (3) Exosystem, (4) Macrosystem, and (5) Chronosystem, which continuously interrelates and affects one another. In the lens of a school, the school microsystem includes the immediate relationships and interactions present between and among teachers, students, administrators, parents, and support staff. Mesosystem level is the connection between microsystems, for example, the competitive relationship among schools through different school activities. Exosystem level refers to the indirect effect of the society (such as the community or neighborhood) on the school. The macrosystem is the level wherein the culture and social values of the school are involved along with resources and opportunities. For example, the relationship of the school's Philosophy, Vision, Mission, and Goals to their desired social ideology of a person (eg. morally decent and spiritually attuned). Lastly, the concept of time (Ashiabi & O'Neal, 2015) in the school's development, the chronosystem level. For example, the temporal sense in the changing relationship of school-teacher-student which relates the shift from a teacher-centered to a student-centered classroom or the temporal dynamics of curriculum change.

Applying this concept to risk and risk management, the researcher sees that at each level, there is an underlying risk waiting to be accidentally unearthed in the course of school development and improvement. Risks at the microsystem level involve the immediate and direct stakeholders of the school; at the mesosystem, the risk of ever-changing competition among schools and the needs of students; at the exosystem level, the risks and dangers of commuting and safety; at the macrosystem level, the risk of molding socially responsive and proactive individuals who are anchored to the school's PMVG; and at the chronosystem level, the risk of the temporal sense of New Normal for schools during this time of the pandemic.

This creates frames at which the school administrators and managers should look on to carefully identify, assess, respond to, and control and monitor the risks. The application of Bioecological Theory in school risk management targets emerging unknown limiting factors as seen in the archetype at different environmental levels.

### 3. Methods

This paper explores the concepts of risk management, systems archetypes, Bioecological Theory, through related literature to draft a model to be used by a school organization in risk management planning. Further, it delves into the application of said concepts to build a strong argument that helps in understanding the proposed school-based risk management model.

### 4. Discussion

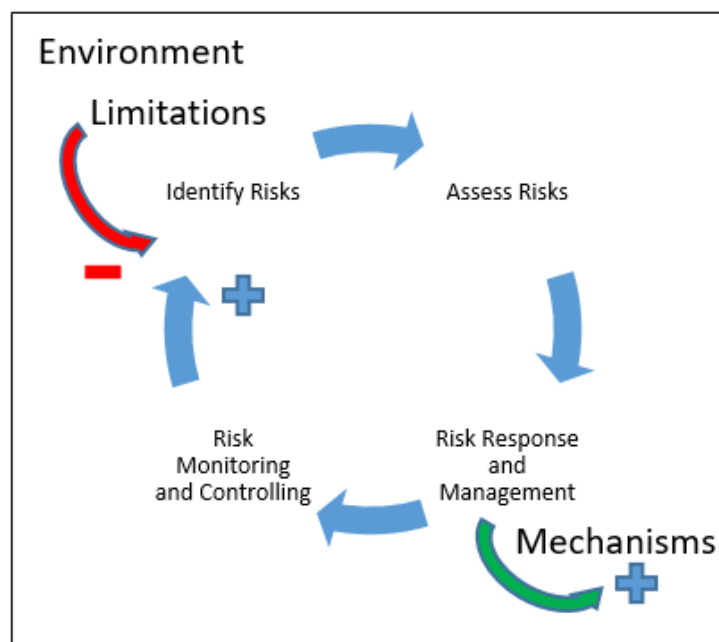


Figure 3. The conceptualized model for school-based risk management.

The researchers argue that the pandemic did not just affect schools on a large scale, but the effects have permeated between the bioecological nests causing a more specific risk-oriented issue that may cause unforeseeable impacts in the future. The model offers a way to solve these issues procedurally.

Risks are dealt with only when they arise because they involve efforts, time, money, knowledge, and skills for proper decision-making. However, the model proposes that school leaders and administrators should always look at their sources at different bioecological layers where the school is nested in. This proactive management of risk develops school leaders and administrators to see things in a greater eye as it involves multifaceted scopes of proximal frames based on the environment, meaning organizations and institutions should earlier identify limitations at each level of the environment that will serve as both an opportunity and risk, not only when these arise. The limitations are seen as a potential disturbance within the normality of the system, which, using the process of risk management, will be strategically corrected through various efforts such as planning and implementation within your system. Once processed, new mechanisms to approach risks will be developed to address particular concerns on a particular bioecological level. Once the new mechanism is applied, in a particular layer, success will be determined if there's a seen reduction in the limits, otherwise, the process begins again. The way of addressing the issue becomes systemic, as it involves the management of risk through archetype analysis, and systematic as it looks into the layers of the environment where the organization or institution is, hence, it is also a dynamic and holistic approach (Guy-Evans, 2020) into viewing risks because it looks into the persistent relationship, influences, and interaction of the school with its immediate surroundings.

The systemic and systematic way of dealing with risks becomes the core attributes of the model. In the context of this proposed model, the bioecological nests or layers as seen through the lens of risk and risk management will be determined as the *proximal frames of risk*, which, by definition in this paper, is the layered context for an emerging set of risks depending on the environment it was observed or analyzed. With this definition, the school leaders or administrators should observe these frames while developing, strategizing, and monitoring for risk and risk management. This poses a challenge to the pre-existing risk management plans, frameworks, and strategies in different schools solely targeting specific concerns that rarely deal with the root cause, but instead, produce solutions that are only symptomatic in nature.

## 5. Conclusion & Future Directions

The paper targeted to conceptualize a new model in the perspectives of risk and risk management, systems archetype, and the Bioecological Theory. Since the emergence of the pandemic, many different kinds of risks emerged causing uncertainty and disturbance in the otherwise normal school operations. This causes a burgeoning of limitations for the schools, which, in turn, causes a negative impact for them. The model posits a systematic and systemic approach in dealing with these risks as seen in each bioecological layer, hoping that it will reduce the negative effects of risks.

The researchers suggest that further research and studies should be undertaken to find out the capacity of the model in helping school organizations and institutions in risk planning. Furthermore, the researchers recommend a series of studies that will look into the concept of seeing risks at the different bioecological nests of a school, specifically: (1) in analyzing the context of proximal frames of risks in order to create

mechanisms/strategies/programs suited for managing a particular risk, (2) in analyzing risk management praxis of schools in line with proximal frames of risks, (3) in understanding the discourse of risk planning and management in view of proximal frames of risks and systems limits, and (4) in the improvement of the model presented.

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## **Current Overview of Undergraduate Nursing Courses in the Northeast**

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**Abstract**

*Introduction: Nursing education has been undergoing transformations in due to the need to adapt to the market demands. Thus, within the academic context, it is necessary to observe the quality of training linked to the demands of the contemporary world. To assess this quality, the National Institute of Studies and Research uses instruments to outline the quality panorama of the courses through the evaluation of students, through the result of the National Student Performance Exam, in addition to using the educational indexes: administrative category, institutional nature, number of vacancies offered and course concept. Objective: To outline the current panorama of undergraduate nursing courses in the Northeast region, establishing a relation with the quality of teaching based on the evaluation of educational indices. Methodology: Document research, of a descriptive character and qualitative approach, using secondary data from the National Institute of Educational Studies and Research Anísio Teixeira of the Ministry of Education, available in April 2020. The sample consists of 336 institutions that offer 406 undergraduate courses in nursing in the Northeast. The data were compiled in an Excel® spreadsheet and statistically analyzed using the SPSS 12.0 program. Results: It was observed that the face-to-face modality stands out with 89% coverage in the region, but distance learning includes the largest number of places. Public education institutions stand out with the higher concepts of the course. The NSPE evaluation concept 2 was the one that most appeared in the evaluated courses. The state of Bahia has the largest amount of courses, with 24.5%, and Sergipe was the lowest index (5.4%), but it has an average of vacancies higher than the average in the region. Final considerations: The analysis of this study shows a deficit in the quality of undergraduate nursing courses in the Northeast. Further studies in the area of Nursing Education are needed to analyze the monitoring of its quality.*

**Keywords:** Nursing education; Higher education institution; Educational assessment.

## 1. INTRODUCTION

The health scenario has been constantly changing, a fact that has led nursing education to transformations, in order to adapt to the demands imposed by the world of work, preparing future professionals with an innovative profile, with relational skills and technical, ethical, human skills and above all, ready to meet the needs of society (LUIZ et al., 2020). In this sense, there are three important aspects to this context: quality in training aligned with the demands of the contemporary world, ability to work in a team and lead the student to critical, creative and ethical thinking (CASSIANI et al., 2017).

The internationalization movement of higher education in nursing emerges as a compulsory requirement for globalization and the need to disseminate knowledge that adheres to social, economic and cultural political development. Thus, the changes that occurred in nursing education in Brazil are linked to the expansion of the course that since the nineties has the purpose of providing autonomy to private Higher Education Institutions (HEI's), and with that there was greater flexibility in the regulatory aspects (TYRRELL, 2019).

In view of this process, the ministry of education realized the need to standardize teaching by creating the National Curriculum Guidelines (NCGs), in which they were published for health degrees, serving as a parameter for the construction of IES Pedagogical Projects (NETO, 2019). The NCGs have become a legal, political and ethical framework in which the training of nurses is advocated, stimulating changes in undergraduate courses in order to improve pedagogical projects and curricula (SILVA et al., 2011). The nurse qualified to practice nursing must be guided by ethical principles, and be able to intervene in the health problems prevalent in the national epidemiological profile (VIEIRA et al., 2020).

The last decades are marked by the construction of new health organizations, these begin to be governed by health promotion, disease prevention and treatment of health morbidities, the effect of the consolidation of the Unified Health System (UHS) in Brazil. Thus, teaching also began to be questioned, since, until then, the training of health professionals was geared towards the medical model (BECERRIL, 2018). With the arrival of UHS in 1988, there was a break in this model, raising questions about the training of health professionals asking whether they were able to work in the current health system in the country (DUARTE; VASCONCELOS; SILVA, 2016).

To assess aspects related to the quality of nursing education, the National Institute of Studies and Research (NIRS) uses instruments to outline the panorama of the quality of courses. Thus, through the National Higher Education Assessment System (NHEAS), it is possible to evaluate such quality indicators: the assessment of students, through the result of the National Student Performance Exam (NSPE), in addition to using the educational indexes: administrative category, institutional nature, number of vacancies offered and course concept. The faculty, physical structure and pedagogical project of the course (PPC) are also evaluated (LIMA, 2016).

At this juncture, this article aims to answer the following research question: From the quality indicators of Nursing Education, what is the evaluation of Nursing courses in the Northeast? In order to answer the proposed question, this research aims to outline the current panorama of undergraduate nursing courses in

the Northeast region, establishing a relationship with the quality of the costs from the assessment of educational indexes.

The discussion of this topic becomes relevant, since, based on the assumption of the unbridled expansion of nursing education, it is important to assess the quality of teaching that is being offered in the HEI's. Thus, when a quality education is provided, it enables the future nurse to develop competencies, skills and attitudes essential for his performance in the labor market.

## **2. METHODOLOGY**

### ***2.1 Study design***

It is a documentary research, of a descriptive character and quantitative approach. The study used secondary data from the universe of undergraduate nursing courses in the Northeast, accessed in the period from April 2020.

### ***2.2 Data collection procedure and participant***

The information collected and analyzed was made available by the National Institute of Educational Studies and Research Anísio Teixeira (NISR) of the Ministry of Education (MEC) registered in the e-MEC database. This is an online tool that manages information about HEI's.

The study sample consists of 336 institutions that offer 406 undergraduate nursing courses in the Northeast. Variables were defined as: type of accreditation, administrative category of the course, concept of the course, NSPE evaluation score and number of places for undergraduate courses. The data obtained were tabulated and submitted to descriptive analysis using the Excel® 2019 software (16.0).

As inclusion criteria, the institutions recognized by the MEC and which are included in the e-MEC database were analyzed. Exclusion criteria were the HEI's that present courses in extinction, that do not have an enrollment number, and the NSPE concept and that offer mid-level nursing courses.

### ***2.3 Data analysis***

The data were compiled in an Excel® spreadsheet and statistically analyzed using the SPSS 12.0 program. Descriptive analysis was performed using absolute and relative frequencies. To compare the categorical variables, the chi-square test was used and for the numerical ones, the Mann-Whitney U test or the Kruskal-Wallis test followed by the Dunn test. The normality of the data was tested using the Shapiro-Wilk test. Associations were considered significant when  $p < 0.05$ .

### ***2.4 Ethical procedures***

The present study does not require approval from the ethics committee in research with human beings for using secondary data that appear on public websites.

## **3. RESULTS**

The e-Mec points to the existence of 336 institutions that offer 406 undergraduate nursing courses in the Northeast region. 89% of registered courses are offered in person, with an average of 150.04 places.

Courses registered in distance learning (DL) represent 11% with an average of 263.98 places (Figure 1).

Figure 1A

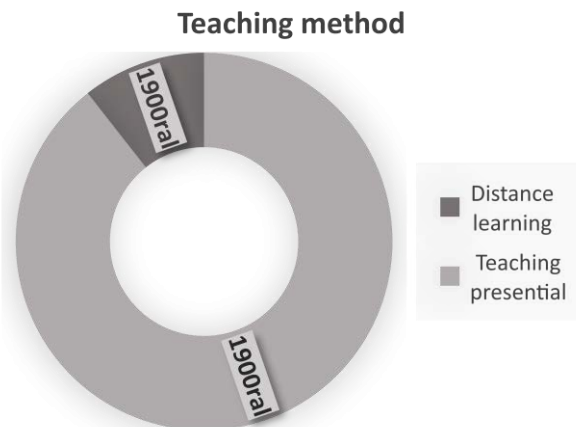


Figure 2A

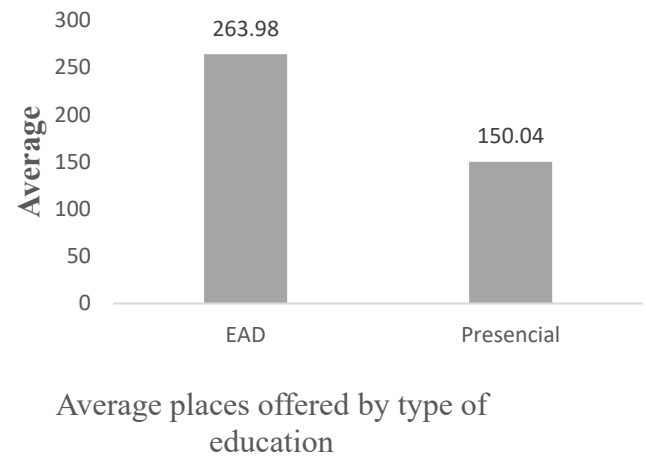


Figure 1 - Teaching modality of undergraduate nursing courses in the Northeastern states (A). Average vacancies offered x teaching modality in the Northeastern states (B).

The courses offered by public HEI's stood out with the highest concepts, with 48.1% presenting concept 4 and 26.9% concept 5. Already private HEI's courses mostly obtained concept 2 (50.4%), followed by of concept 3 with 30.9%. Evaluating the minimum concept (1), it is clear that no course from public institutions presented this note. On the other hand, there are only 1.4% of courses from private institutions with a maximum grade ( $X^2 = 86.96$ ,  $p < 0.001$ ) (Figure 2A).

As for the concept of NPSE acquired by nursing courses in the Northeast, it is clear that most presented concept 2 (37.5%), 26% concept 3 and 21% concept 4. The lowest rates highlighted were the maximum concept 5 (9.5%) and the minimum concept 1 (6%) (Figure 2B).

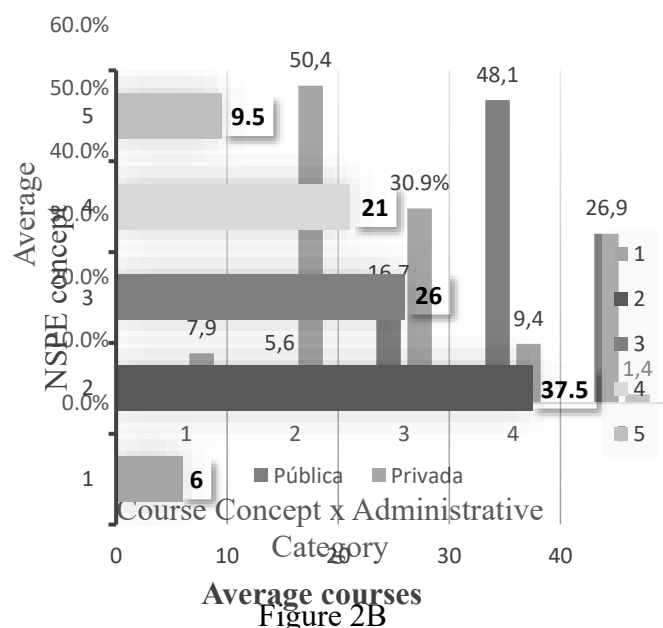


Figure 2A

Figure 2 - List of the course concept by administrative category of Higher Education Institutions in nursing in the Northeast region (A). NSPE concept of undergraduate nursing courses in the Northeast region (B).

The number of undergraduate nursing courses in Bahia is 99 (24.5%), this being the state with the largest number of courses in the region, followed by Pernambuco with 64 (15.8%), Ceará with 55 (13, 6%). The state with the lowest number of courses is Sergipe, 22 (5.4%) (Table 1).

Table 1 - Rate of courses and average vacancies offered by Higher Education Institutions in nursing in the states of the Northeast.

REGION	n (%)	n (%)	Average vacancies	Standard deviation
BA	47 (11.6)	5,237 (8.0)	111.4	85.2
PI	33 (8.2)	3,755 (5.7)	113.8	73.9
CE	55 (13.6)	7,883 (12.0)	143.3	77.6
AL	26 (6.4)	4,047 (6.2)	155.7	121.0
SE	22 (5.4)	3,737 (5.7)	169.9	146.8
PB	30 (7.4)	5,151 (7.9)	171.7	159.5
RN	28 (6.9)	4,836 (7.4)	172.7	178.4
BA	99 (24.5)	17,878 (27.3)	180.6	278.1
PE	64 (15.8)	12,991 (19.8)	203.0	212.5
TOTAL	404 (100)	65,515 (100)	162.2	186.6

The average number of vacancies in the states was carried out as follows: the number of vacancies in each state was divided by the number of courses in the respective state. Thus, the average number of vacancies offered by undergraduate nursing courses shows that of the 9 states in the Northeast, the state of Pernambuco stands out with the highest average (203.0, SD 212.5), being it the fifth largest state the region in territorial dimension. The Bahian territory had an average of 180.6 (SD 278.1) and is the second state with the highest average.

Sergipe is the smallest state in the region in terms of territorial extension and has the lowest number of institutions and courses offering undergraduate nursing. This state stands out when comparing the average number of vacancies offered (169.9, DP 146.8) with such states: Alagoas (155.7, DP 121.0), Ceará (143.3, DP 77.6), Piauí (113.8, SD 73.9) and Maranhão (111.4, SD 85.2).

#### 4. DISCUSSION

The quality of undergraduate nursing courses involves several aspects that aim at a whole context to achieve an approximation with the reality that these courses are inserted in. Thus, it is necessary to observe the



indices that are involved in the training of nurses as part of a survey of information that supports the process of improving the quality of teaching. Among these indices we can highlight: rate of teaching modality, average of vacancies offered, rate of the course concept, rate of administrative category, rate of the concept of NSPE and number of existing courses (CORRÊA; SANTOS; KOBİ, 2014).

In this study, it was possible to analyze 336 higher education institutions in nursing in the Northeast, of which 89% contemplate the face-to-face modality and 11% DL. Martins et al. 2019, in its study shows the growth of DL courses in Brazil, in which in the year 2004 it was not possible to identify courses in this modality, already in 2016 a quantity of 100 courses was observed. The same justifies that the Northeast region is the first region in the country with the largest number of DL courses and that the expansion of higher education occurred with the opening of this type of course.

Even considering 11% of the total number of nursing courses in the Northeast, the DL modality has impacts that can have an impact on the professional life of the future nurse. Nursing training is considered to require strengthening bonds of trust, requiring in-person care and guidance (LIRA et al., 2020). The Federal Nursing Council (FNC) takes a stand against DL in this area, but an expressive number of courses of this modality in the Northeast region is still noticeable.

There is also an expressive average of vacancies in DL nursing courses (263.98) in the region under study. This occurs due to its large territorial extension and historical factors of underdevelopment, such as difficulty of access, mainly in locations furthest from the capitals (MARTINS et al., 2019).

The courses offered by public HEI's in the Northeast region stood out with the highest concepts and had no minimum concept. Private companies stood out in concept 2 (50.4%), followed by concept 3 with 30.9% and only 1.4% with maximum concept. Even the private institutions with the highest number of HEI's, it can be observed that it contains a deficit in the quality of the results obtained in the evaluation of the course. The number of enrollments in undergraduate nursing courses has increased considerably in recent decades. Private HEI's have been experiencing an unrestrained expansion in these enrollments, which is closely linked to the quality control of teaching, reflecting on the formation of the future professional (CORRÊA; SANTOS; KOBİ, 2014). Even with the increase in the number of courses, it was not possible to notice efforts for a correct planning of this growth aiming at academic improvement with regard to the articulation of teaching and learning (LIMA, 2016).

NISR evaluates the quality of undergraduate courses through the evaluation of NSPE, which has a value from 1 to 5, as the value of the concept increases, better teaching quality is observed. Of the 406 existing courses in the Northeast, 37.5% presented concept 2, 6% concept 1 and 9.5% concept 5. Such data corroborate with the research of Lima, 2016 in which concept 1 is observed with 3%, concept 2 with 18% and concept 5 with 6%. Thus, it is noted that most courses do not meet the minimum quality criteria assessed by NSPE. These results indicate that even with the expansion of installed undergraduate courses, there is no training with very good indicators (CABRAL et al., 2013).

In the study by Frota et al., 2020, Brazil in the 1960s had 34 undergraduate courses in nursing and in 1988, 103. In 2000, the country obtained 183 courses and in 2014 881, so there is a potential increase in these numbers (PIERANTONI; MAGNAGO, 2017). In 2020, only the Northeast region, which has more states, stands out with 404 courses, in which the Bahian territory contains 24.5% of these, Pernambuco 15.8% and Sergipe 5.4%, being the smallest state and presenting the smallest rate. The increase in the number of

nursing courses in Brazil and, consequently, in the number of places available, refers to health needs and social demands to meet the job market (FROTA et al., 2020).

In the Northeast, the average number of vacancies per state is 162.2, with a total of 65,515 vacancies, with Pernambuco (203.0) and Sergipe (169.9) having averages higher than the general average of the region. Maranhão (111.4) is the state with the lowest average, being below the regional average. Pierantoni and Magnago, 2017 in their study point out that in 2000 Brazil reached 20,417 vacancies for undergraduate nursing, and in 2014 178,264. Even though the Northeast is not the most populous region in the country, it has a considerable vacancy rate (36.7%) when compared to this 2017 study.

## 5. Conclusion

The analysis carried out in this study points to a deficit in undergraduate nursing courses in the Northeast region. In view of such data, it is concluded that this increase in HEI is linked to the capitalist and mercantilist model, in which there is a concentration of private institutions and that this quantity is not equivalent to the concept acquired by them, which influences the quality standard.

Thus, there is an urgent need for new studies in the area of Nursing Education that have been showing accelerated and disordered growth of courses and the offer of vacancies without the proper monitoring of their quality. The quality indicators analyzed in this study, such as NSPE and the course concept, show that the expansion of the growth of courses in an uncontrolled way has an impact on the formation of critical and reflective nurses to attend to the individual's health in a holistic way, not developing skills and skills in professionals so that they can know and intervene in health-disease situations.

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# ANALYSIS OF SCIENTIFIC PRODUCTION IN THE FIELD OF SUSTAINABLE TOURISM: WEAVING NETWORKS OF KNOWLEDGE

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## Abstract

*The aim of this research was to investigate the dynamics of scientific production in the field of sustainable tourism, emphasizing the collaboration network, knowledge generated and the key authors and institutions that contribute to the advancement of knowledge. Information was collected from articles, books and proceeding papers using the Web of Science (WoS) platform from 1990 to 2018. A total of 7,051 documents were analyzed. Data were analyzed using network analysis and bibliometric indicators. Based on the information collected, scientific production linked on the economic pillar, particularly regarding terms such as sustainable tourism, tourism, management, sustainable development, sustainability, ecotourism and conservation. Thus, we found that the dynamics of collaboration in scientific production in sustainable tourism has a dense geographic network and proximity of themes as elements for structuring the knowledge network.*

**Keywords:** Bibliometrics; Collaboration networks; Sustainability pillar.

## 1. Introduction

The annual growth of tourism activity generates income and employment, and it is often the main economic activity of a locality. This growth has positive and negative impacts, the latter being more frequent. Hence the need for alternatives that promote the sustainability of the location without devastating the physical and sociocultural space. In this conception, Körössy (2008) argues that the aspirations for sustainability come from academic, ideological and technological reflections on the current process of

social and economic development that lead to new ideas of thinking that address and act on the processes and phenomena of development.

From the perspective of tourism, it has been argued that sustainable tourism is a segment that seeks the balance of natural ecosystems, it is linked to local sustainability in which the visitor, who is open to new discoveries, understands the identity of the place and respects its customs (Hanai & Espíndola, 2011). The dynamics is in line with the definition of sustainable tourism established by the United Nations Environment Programme [UNEP] and World Tourism Organization [UNWTO] (2005) as one that “Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities.” (p. 12) Within this scenario, Niedziółka (2014) argues that sustainable tourism should also maintain a high level of tourism satisfaction and ensure a meaningful experience for tourists by raising awareness of sustainability issues and promoting sustainable tourism practices.

In the current scenario, research has endeavored to understand the dynamics of sustainable tourism. In this field, Buckley (2012) and Qian, Shen and Law (2018) argue that sustainable tourism are central elements in reflections in different fields of knowledge. Within this perspective, empirically studying the dynamics of scientific production is important to obtain a series of analyses that will provide a panoramic view and enable the understanding of the current state as well as visualize trends to understand the structure and dynamics of studies.

In this sense, the aim of the present study was to analyze how scientific production in the field of sustainable tourism is organized. Moreover, we intend to identify the authors, types of publications and fields of knowledge, analyze the themes adopted in the development of knowledge in the field of sustainable tourism and map the scientific collaboration network of institutions.

Among the studies on this theme, Buckley's work (2012) analyzed the scientific production of 250 selected articles on sustainable tourism with the following themes: population, peace, prosperity, pollution and protection, but found little adherence to these themes. Zolfani, Sedaghat, Maknoon and Zavadskas (2015) analyzed the scientific production on sustainable tourism in six databases from 1993 to 2013. Ruhanen, Weiler, Moyle and McLennan (2015) studied 492 papers from four journals, *Annals of Tourism*, *Journal Sustainable Tourism*, *Journal Research and Tourism Management*, and they concluded that the theoretical and methodological approaches have developed.

Adopting bibliometric techniques and having as the study object articles published in the *Journal of Sustainable Tourism (JST)*, the studies of Lu and Nepal (2009) analyzed articles published from 1993 to 2007; Mauleon-Mendez, Genovart-Balaguer, Merigo and Mulet-Forteza (2018) investigated publications over the last twenty years, and Qian et al. (2018) conducted a research from 2008 to 2017. Among these studies, Qian et al. (2018) propose that research be conducted to increase the database of journals in the fields of tourism and multidisciplinary fields to present a broader view of the status quo of research in sustainable tourism.

This is where this article aims to contribute. Thus, the present study is in agreement with the aforementioned studies and adds to knowledge by endeavoring to trace a profile and analyze the type of collaborative network on sustainable tourism from the data available on the Web of Science platform from 1990s to 2018.

To achieve the main purpose, the study is divided into three sections, in addition to the introduction. Next, in the second section, we present the methodological procedures. In section three we discuss the results, and in section four we present the concluding arguments of the study.

## **2. Data and Method**

To meet the research objectives for the analysis of scientific production in the field of sustainable tourism, bibliometric indicators were chosen together with Social Network Analysis (SNA). The bibliometric indicators have been used for three purposes: to describe, monitor and evaluate scientific and technological activities (Santos, 2015). As for SNA, it was used to analyze the structure of scientific fields (Newman, 2001a, 2001b, 2004; Wagner & Leydesdorff, 2005; Corral, Kennan & Afzal, 2013) to understand behaviors and processes of the degree of connectivity of co-authors. Thus, the interaction between bibliometrics and SNA is an important instrument for analyzing the structure of science (Otte & Rousseau, 2002).

For information collection, we chose the Web of Science (WoS) platform, available on the Institute for Scientific Information (ISI) on the Web of Knowledge platform. The search for information took place on January 30, 2019. The search was restricted to articles, book reviews and proceeding papers published from 1990 to 2018. The decade of 1990 was chosen because it marks the beginning of discussions related to the term 'sustainability' after the United Nations Conference on Environment and Development (Eco-92), and the term 'tourism sustainable' began to be used in the scientific literature (Buckley, 2012).

The articles were located by using the term 'sustainable tourism'. After the articles were located, the data were extracted following two steps. The first step consisted of collecting files and exporting them to bib.excel, VOSviewer, Ucinet and Netdraw software. The information was then organized in tables and figures and submitted for analysis. The variables collected during this stage were: number of articles published, year of article publication, author and co-author affiliation, language, field of knowledge, journal title and citation frequency of the article.

To analyze the cooperation pattern among institutions, we adopted two SNA-specific metrics, measures of centrality and density. We chose these indicators because it is possible to verify how knowledge sharing takes place among the institutions with greater cooperation levels (Grácio, 2018).

The second step consisted of collecting keywords and abstracts. Considering the extensive number of keywords, we decided to select those with 50 or more co-occurrences. The choice was based on the understanding that when the authors choose the keywords, they acknowledge the association between certain terms, and thus it can be assumed that this relationship has a meaning within the field of study (Robredo & Cunha, 1998).

As for the abstracts, only those with 140 or more citations were analyzed. Thus, thirty-six articles composed the sample to identify on which pillars of sustainable tourism and themes knowledge was based on. The choice to work with the most cited articles was due to the understanding that by citing certain authors in the discussion section of an article demonstrates the proximity of issues between the cited authors from the perspective of citing authors (Grácio & Oliveira, 2013). Thus, the incidence of co-citation



may represent research foci with similar themes, but different approaches (Braam, Moed & Van Raan, 1991), which was a way of monitoring emerging themes in the study area.

To organize the process of collecting and systematizing information, the four pillars of sustainable tourism were adopted as reference, as proposed by Bruyn (2014), as they contain the “Framework for tourism sustainability” that establishes the corresponding terms to the four pillars of sustainable tourism and presents the dimensions and elements linked to these pillars. This document was chosen because it is in line with the twelve objectives and five pillars of sustainable tourism proposed by World Tourism Organization [UNWTO] (2013) and is in agreement with the studies by Janusz and Bajdor (2013). By using this document, it was also possible to relate the researched themes with the terms included in each pillar of sustainable tourism, as shown in Table 1.

In an endeavor to verify which pillar has been discussed in the scientific production, we decided to categorize the clusters based on keywords using those with a largest number of co-occurrences and the most cited articles. The latter took into account the approach of discussions based on what was seen in the abstracts of the thirty-nine most cited articles. Thus, to include the article within the pillar of sustainable tourism, content analysis was adopted as it enables the researcher to categorize, describe and interpret the content of documents and texts (Bardin, 2006; Mozzato & Grzybovski, 2011).

Due to the interdisciplinary nature of the research in the field of sustainable tourism and given the possibility of themes and studies that would allow them to be categorized into more than one pillar, we opted to include the article in a single pillar. This dynamic took into consideration the dynamics discussed in the abstract as well as the subjective view of the researchers during the reading.

Table 1 – Framework for tourism sustainability: Dimension, Element and goal assigned to “Pillar” of sustainability.

Sustainable tourism pillars	Dimension	Element	Goal
Economic Pillar	Tourism Satisfaction and Seasonality	Tourism Seasonality	Defined as the generation of prosperity at different levels of society and addresses the cost effectiveness of all economic activities.
		Tourism satisfaction	
	Supply chain	Leakages	
		Tourism Operations & Services	
	Business Development	Investment	
		Macro Economic	
		SMME Support	
	Marketing, Branding and Competitiveness	Positioning	
		Product Demand	
		Sustainability offer	
	Community Participation	Community Participation	Based on the respect of human rights and equal opportunities
	Community Satisfaction	Community Satisfaction	

<b>Socio-Cultural Pillar</b>	Living Culture	Living Culture	for all members of society requiring an equitable distribution of benefits. The social and cultural heritage of the area plays an important role in tourism, particularly in areas with high cultural or artistic value, or in places where local traditions and values play a significant role.
	Socio Economic Employment	Socio- Economic	
		Employment	
<b>Environmental Pillar</b>	Natural Resources Management	Energy	Defined as the conservation and management of resources, including natural and cultural resources, bio-diversity and waste management.
		Water	
		Climate change	
	Waste Management (Limiting impact on tourism activity)	Solid Waste	
		Residual Water Waste	
	Bio- diversity Management	Habitat	
		Species	
	Cultural Resources Management	Protection	
		Preservation	
		Historic Designation	
<b>Transversal Pillar</b>	Global governance	Funding	Provides support to the Economic, Socio-Cultural and Environmental pillars.
		Legislation	
		Monitoring	
	Safety and Security	Safety and Security	
	Destination Planning	Destination Planning and Control	
	Infrastructure, Services and User Intensity	Transportation	

Source: Adapted from Janusz and Bajdor (2013), UNWTO (2013); Bruyn (2014).

The information was processed in the software as described below:

1) Bibexcel (Umeå University, Umeå, Sweden) was used for extracting scientometric data and create the frequency files; 2) VOSviewer version 1.6.9 was used to visualize clusters and co-occurrence networks; 3) Ucinet, version 6 (Borgatti, Everett & Freeman, 2002) was used to calculate of centrality and density measurements; 4) Netdraw version 2.09 (Borgatti, 2002) was used to build the co-authoring networks of the most collaborative institutions. Figure 1 systematizes the procedures adopted for data collection and analysis.

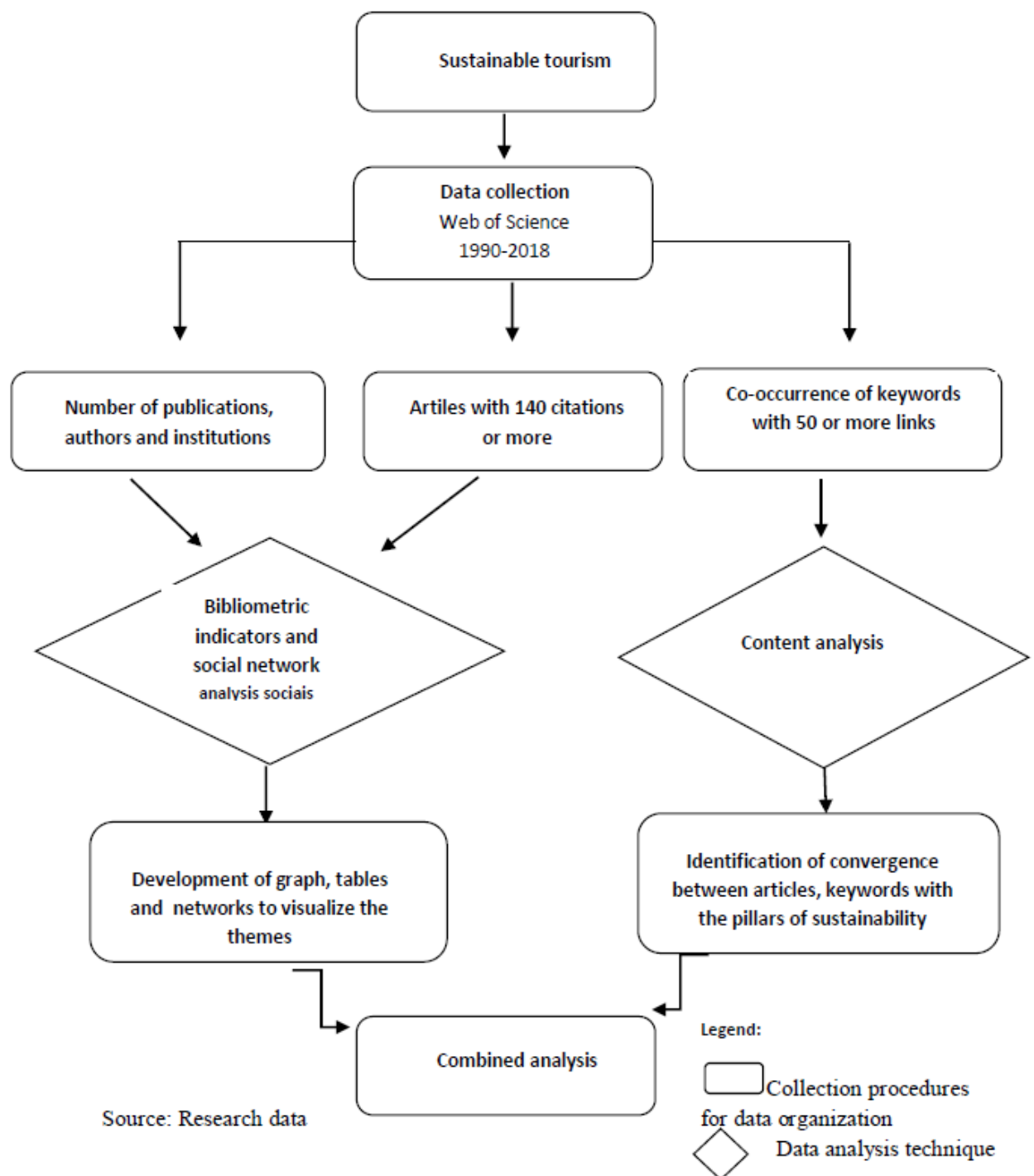


Figure 1 – Flowchart of the method used to collect and analyze data.

Based on the procedures described above, the following section is dedicated to discussing the analysis of the results related to scientific production in sustainable tourism.

### 3. Analysis of results

#### 3.1 Outlining the profile of the scientific production network on sustainable tourism

The scientific production network in the field of sustainable tourism consists of 13,835 researchers in the category of authors (29.34%) and coauthors (70.66%) and 7,051 publications during the period under study. These professionals are affiliated to institutions in 150 countries.

The scientific production network has an average of 3.58 authors per publication and an average of 3.35 institutions. The largest number of coauthors was 24 from 5 different institutions. To disseminate the research results, researchers used different types of publications: articles (60.07%), proceedings papers (34.30%), book reviews (1.81%), and others (3.82). Regarding language, there was a prevalence of English (92.76%), followed by Spanish (3.52%), and other languages (3.72%).

Taking as a parameter the period from 1990 to 2018, we found that scientific production on sustainable tourism increased considerably in the 2000s (Figure 2), with emphasis on the periods between 2010 and 2018, which, in relation to the previous quadrennium periods, showed considerable increase (78.67%). Dynamics show a growing interest among researchers that enabled the dissemination of knowledge in this field of study.

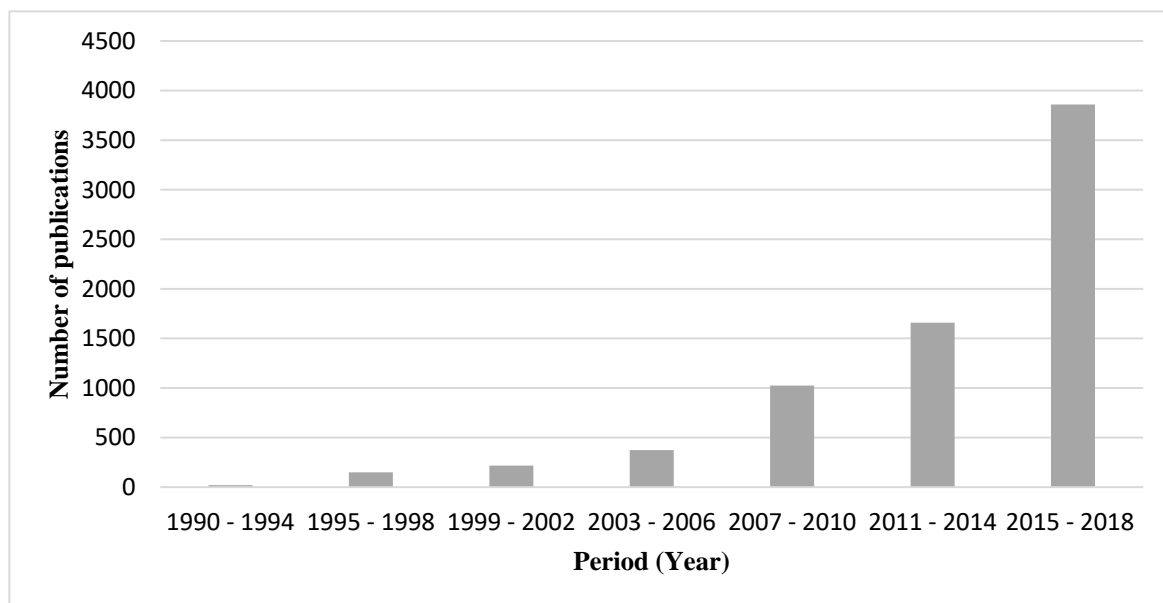


Figure 2. Evolution of scientific production in the field of sustainable tourism. Web of Science, 1990-2018.

Source: Research data

Regarding the articles available on WoS, we found that the researchers contributed to 918 journals, particularly in the Journal of Sustainable Tourism, which was the first journal created to promote critical and innovative thinking regarding the relationship between sustainability and tourism (Qian et al., 2018). As for the impact factor, the largest number of articles were published in journals with an index between 0.6 and 5.6 (Table 2).

Table 2. Journals with the largest number of articles published (frequency  $\geq 30$ ) and their impact factor. Web of Science, 1990-2018.

Journals	Number of articles	Impact factor
Journal of Sustainable Tourism	404	3,32
Sustainability	214	2,07
Tourism Management	209	5,92
Annals of Tourism Research	90	5,08
Journal of Cleaner Production	72	5,65
Current Issues in Tourism	65	3,46
Ocean Coastal Management	63	2,27
Journal of Environmental Protection And Ecology	57	0,67
Journal of Coastal Research	50	0,80
Asia Pacific Journal of Tourism Research	48	1,35
Tourism Geographies	48	2,06
International Journal of Sustainable Development And World Ecology	45	2,37
International Journal of Tourism Research	45	2,44
Journal of Travel Research	38	5,16
Marine Policy	38	2,10
Tourism Management Perspectives	38	1,77
Tourism Planning Development	35	-
Amfiteatru Economic	33	0,66
Worldwide Hospitality and Tourism Themes	32	-
Pasos Revista de Turismo y Patrimonio Cultural	30	-

Source: Research data

In a study conducted by Qian et al. (2018), the publications in the Journal of Sustainable Tourism, Tourism Management and Annals of Tourism Research appear among the most cited journals, which indicates that they are a reference in the field of sustainable tourism.

Analyzing the knowledge area of the published articles we found that knowledge in sustainable tourism is connected to the following areas: Social sciences or other topics, Environmental Sciences Ecology, and Science Technology or other Topics (Figure 3).

**Social sciences other topics (36,97) Enviromental Sciences Ecology (20,29) Science Technology Other Topics(14,47) Engineering (7,04) Sociology (4,86) Geography (4,80) Geology (3,63)Water Resources (3,21) Computer Science (3,03) Urban Studies (2,82) Education Educational Research (2,42) Physical Geography (2,15)Agriculture (2,07)Biodiversity Conservation (1,89).**

Figure 3. Cloud of words related to the knowledge area (percentage) of articles published in the field of

Sustainable Tourism. Web of Science, 1990-2018.

Source: Research data

Regarding the three areas with the highest percentage of articles, it can be seen that the nature of research in the field of studies called multi and interdisciplinary (Zolfani et al., 2015) consist of a set of disciplines that discuss various topics, as it can be seen in the keyword network analysis used by the researchers.

The list of keywords used in the articles published in the study area is shown in Table 3. The table makes it possible to visualize the terms that surround scientific production and, consequently one can see their correspondence with the pillars of sustainable tourism mentioned in Table 1.

Considering and analyzing the group of the keywords with more than 50 co-occurrences as reference, five groups were formed by the clusters, according to the similarity pattern of words used. It should be noted that the closer the keywords are, the more they complement knowledge generated and linked on the network.

Table 3. List of keywords with the highest co-occurrence in the field of sustainable tourism, organized by cluster and pillar. Web of science, 1990-2018.

Keywords	Cluster and pillar				
	1	2	3	4	5
Attitude		EC			
Behavior			EC		
Climate change					EM
Communities		EC		SC	
Conservation				EM	
Destinations	EC				
Economic	EC				
Ecotourism		EC		EM	
Environmental	EM				
Governance		EC			
Heritage			SC		
Impact	EC	SC			
Indicators		EC			
Industry	EC				
Management		EC		SC	
Model		EC			
Participations		SC			
Responsability	EC				
Rural tourism	EC				
Sustainability	EC	EC	SC		TR



Sustainable development	SC	EC			
Sustainable tourism	EM	EC			
Tourism	EC	TR	SC	EM	

Note: EC - Economic pillar, Socio-cultural pillar (SC), Environmental pillar (EM), and transverse pillar (TR)

When analyzing the keywords with the highest occurrence, we found the following: sustainable tourism, tourism, management, sustainable development, sustainability, ecotourism and conservation. Among the terms, “sustainable tourism”, “tourism” and “ecotourism” were among the most cited words in research by Mauleon-Mendez et al. (2018). The term ecotourism appears in the research conducted by Qian et al. (2018), which formed a cluster.

When relating the keywords with the pillars of sustainable tourism, the focus of studies is on the Economic (EC) pillar, and there are fewer studies on the socio-cultural (SC), environmental (EM), and transverse pillar (TR) perspective. A possible justification for this dynamic may be because seminal studies are linked to the themes on tourism, economics and environmental management (Buckley, 2012).

It is worth noting that among the themes in the scientific production, there are few discussions on the themes that address the terms “habitat” and “species” in the dimension of “Bio-diversity Management” listed on the Environmental pillar. When addressing these issues, the literature takes an interdisciplinary approach to address biodiversity management by using the term “ecological footprint” (Gossling, Hansson, Hörstmeier & Saggel, 2002), to understand tourism by focusing on conservation of endangered species and habitats (Kruger, 2005), and analyze the impact of commercial activity on the environment (Primavera, 2006).

As for the transverse pillar perspective, studies do not discuss the themes “funding” and “legislation”, included in the dimension of “Global governance”. A possible explanation for this situation may be because they have a more technical approach containing information from reports and documents, such as the studies by UNWTO (2013), Bruyn (2014), World Tourism Organization [UNWTO] (2017) and Organisation for Economic Co-operation and Development [OECD] (2018).

To understand what is being studied and proposed by the three most frequently occurring words and the thirty-nine most cited articles (Table 3), we found that studies using the term ‘sustainable tourism’ focused on the analysis of research developed in the field of sustainable tourism (Buckley, 2012), development of indicators (Miller, 2001), suggestions of tools to evaluate tourism sustainability (Gossling et al., 2002), studies on the experience of visitors and local consumers (Sims, 2009), and governance following a political economy approach (Bramwell, 2011). The term ‘tourism’ refers to studies that deal with environmental consequences (Gossling, 2002), eco-efficiency (Gossling et al., 2005), further understanding of the concept of tourism (Farrell & Twining-Ward, 2004) and mindful visitors (Moscardo, 1996).

Regarding the term ‘management’, we found studies that address the proposal of sustainability indicators for the study of management of community tourism (Choi & Sirakaya, 2006), tourist destination (Mihalic, 2000), heritage tourism (Garrod & Fyall, 2000), and they apply the stakeholder theory as a model for normative planning and relationship strategy (Sautter & Leisen, 1999).

The most frequently cited articles are those that adopt a theoretical discussion and point to definitions, such as the studies by Hunter (1997), Gossling (2002), Choi and Sirakaya (2006) and Saarinen (2006).

Table 4. Organization of the thirty-nine articles with the highest number of citations in the field of sustainable tourism by pillar of sustainable tourism. Web of Science, 1990-2018.

Pillar	Articles
<b>Economic</b>	(Mihalic, 2000); (Miller, 2001); (Font, 2002); (Gossling et al., 2002, 2005); (Wang & Fesenmaier, 2004); (Aguilo, Alegre & Sard, 2005); (Choi & Sirakaya, 2006); (Garrod, Wornell & Youell, 2006); (Okazaki, 2008); (Dwyer, Edwards, Mistilis & Roman, 2009); (Sims, 2009); (Miller, Rathouse, Scarles, Holmes & Tribe, 2010); (Bateman, Georgina, Fezzi, Atkinson & Turner, 2011); (Bramwell, 2011); (Nunkoo & Ramkissoon, 2011); (Gossling, Scott, Hall, Ceron & Dubois 2012).
<b>Socio-Cultural</b>	(Moscardo, 1996); (Garrod & Fyall, 2000); (Briassoulis, 2002); (Kiss, 2004); (Sims, 2009); (Barr, Shaw, Coles & Prillwitz, 2010); (Ballantyne, Packer & Sutherland, 2011); (Lee, 2013).
<b>Environmental</b>	(Reynolds & Braithwaite, 2001); (Gossling, 2002), (Loumou & Giourga, 2003), (Bejder et al., 2006); (Aburto-Oropeza, Ezcurra, Danemann, Valdez, Murray & Sala 2008).
<b>Transverse</b>	(Hunter, 1997); (Sautter & Leisen, 1999); (Hall, 2001, 2011); (Ryan, 2002); (Kruger, 2005); (Primavera, 2006).

Source: Research data

By analyzing the clusters generated through the co-occurrence of words and the most cited articles (Table 4), we found that studies generally focus on impacts, attitudes, perceptions, determinants, perspective, collaboration, climate change, governance, policy, biodiversity, and their study objects are: stakeholders, communities, national parks, protected areas and policies. These studies also seek to discuss models, indicators and theoretical frameworks.

This result leads us to infer that the practice of sustainable tourism requires planning, development and use of sustainability indicators to improve tourism management, participation of the local community in the planning and monitoring of activities, and partnerships that combine governments, private enterprises and communities (Ruhanen-Hunter, 2006; Graci & Dodds, 2010).

In this aspect, the term 'management' requires further explanation. The summary representation of content analysis shows that the studies are largely connected to research conducted by researchers residing in Oceania, particularly New Zealand and Australia. From this perspective, it must be pointed out that one third of New Zealand's territory is under protection including world heritage sites, national, maritime and forest parks and wilderness areas.

Tourism is a key component of New Zealand's economy, contributing 3.3% of gross domestic product (Simmons, 2013). In addition, New Zealand ranks second place, second only to Australia, among the top ten sustainable tourism reference economies, and it has an official quality warranty system for

assessing the level of environmental sustainability of businesses in the tourism sector.

It is noteworthy that some peripheral themes that have a lower number of link strengths (e.g. governance, perception, attitudes, climate change, heritage, communities, destinations) presented a high frequency and interact with the themes with the highest number of link strengths.

Another point to keep in mind is the geographical dimension that the authors adopted in the research. Among the countries studied, the largest number of studies were from Australia, New Zealand, Canada, South Africa and China.

When analyzing the geographical location of institutions where the researchers live, China is responsible for 17.86% of the articles published, ranking first, followed by the USA with 8.82%, and Australia (7.47%). The dynamism presented by China follows a world trend. According to data presented by Tollefson (2018), China ranked first in number of scientific publications, surpassing the United States in 2018. Among these results, except for China, the other countries included in the study conducted by Lu and Nepal (2009) indicate the significance of these countries, as well as the awakening of Chinese researchers to the study of sustainable tourism. It should be noted that China, together with the United States and Germany, are the countries that receive the largest number of tourists in the segment 'overnight visitors' (UNWTO, 2017).

### 3.2 Authors

Table 5. Authors by number of publications and number of citations in the field of Sustainable Tourism, 1990-2018.

Author	Number of publications	Number of citations	Average of citations	Total Strong links	University	Country
Gossling, S.	30	1782	59,4	36	Lund U.	Sweden
Hall, C.	21	844	40,19	23	U. of Canterbury	New Zeland
Scott, D	10	654	65,40	20	W. of Waterloo	Canada
Bramwell, B.	24	648	27	25	Sheffield Hallam U.	UK
Nunkoo, R.	13	512	39,38	9	W. of Waterloo	Canada
Ramkisson, H.	9	495	55	8	Curtin U.	Australia
Dolnicar, S.	14	484	34,57	3	U. of Queensland	Australia
Miller, G.	10	458	45,8	12	University of Surrey	UK
Hunter, C.	7	455	65	1	University of Aberdeen	UK
Saarinen, J	13	428	32,92	2	University of Oulu	Finlandia

Source: Research data

Regarding the most influential authors (Table 5), the largest number of publications and citations was for the author Gossling, S. In a detailed analysis of publications, scientific production was related to sustainability and focused on transport, mobility, energy and water. The main authors were Paul Peeters

(Peeters, P.), affiliated to the NHTV Breda University for Applied Sciences, and Daniel Scott (Scott, D.) from the University of Waterloo.

Among the most cited articles (195 citations), the theme “Consumer behavior and demand response of tourists to climate change” (Gossling et al., 2012) was the most frequent. The article has three coauthors, among which Gossling, S. is one of them, who has the largest number of articles, as mentioned above. This article is one of the ten most cited on the WoS platform related to the scientific production of sustainable tourism. It is important to highlight that these authors have been collaborating since 2008, and five articles focusing on discussions on climate change and tourism are the result of their partnership.

The data shown in Table 5 are similar to the research conducted by Qian et al. (2018), in which five authors are among the ten most cited. Their work is convergent with the studies by Mauleon-Mendez et al. (2018), which among the fifty most productive authors, four (Okazaki, 2008; Sims, 2009; Bramwell, 2011; Hall, 2011) appear in the present study. Another author who draws attention is Gossling, S., who was the most productive, which is in line with the present study. Given that the research was restricted to the Journal of Sustainable Tourism (JBS), and it is the only one in the Web of Science database, it is understood that, irrespective of the breadth of research, the above-mentioned authors are the most representative ones in the field of sustainable tourism.

By correlating the overall number of publications and citations, academic production has a low correlation with the number of citations. The correlation coefficient revealed a significant result ( $R^2 = 0.47$  and  $p = 0.05$ ). Within this scenario, one must draw attention to the author Garrod, B., who has 5 publications with 624 citations, an average of 124.8 citations for each article, while Gossling, S. has an average of 74.10 citations per publication. An analysis of the first author's curriculum reveals that he is affiliated to Swansea University and his research focuses on the fields of destination marketing and management, heritage tourism, ecotourism, sustainable tourism and cultural marketing. The second author is a professor at Linnaeus University, and he conducts research on tourism and climate change, tourism and development, renewable energy, low-carbon tourism and climate policy.

### **3.3 Institutions**

The scientific production in the field of sustainable tourism included 4,573 institutions. Among these, nine institutions stand out for having a larger number of publications (Table 6). From the data shown in Table 6, production from the Griffith University ranks first position in number of documents, followed by the Chinese Academy of Sciences. When analyzing the country of the institutions studied, Australia and China rank higher than other countries.

Table 6. Institutions with the greater number of publications on sustainable tourism, 1990-2018.

Institutions	Country	Number of publication
Griffith univ	Australia	110
Chinese acad sci	China	72
Univ queensland	Australia	69
Tianjin Univ Finance & Econ	China	56
Bucharest Univ Econ Studies	Romania	49
Hong Kong Polytech Univ	China	49
Univ Waterloo	Canada	49
Univ Johannesburg	South Africa	44
James Cook Univ	Australia	40

Source: Research data

As for the collaboration network, only the institutions with five or more partnerships were selected and the VOSviewer software combined 391 institutions. Regarding the sharing of knowledge, the institutions were grouped into 29 clusters. Due to the large number of institutions in the study, the analysis of institutional collaboration was conducted with the group of 13 institutions with the highest frequency of collaboration and the VOSviewer software identified the number of link strengths. After the institutions were identified, the institutional collaboration network was built using the NetDraw software, as shown in Figure 4.

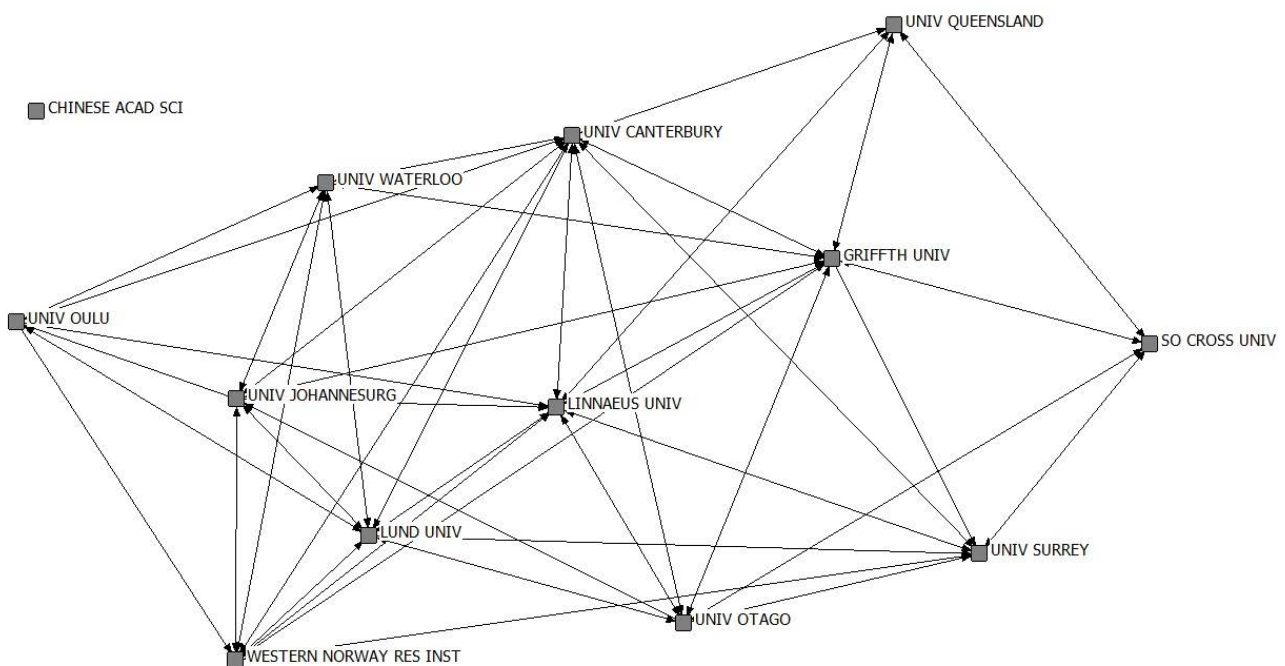


Figure 4. Institutional collaboration network in the field of sustainable tourism, 1990-2018.

Source: Research data

Geographic analysis of the most collaborative institutions revealed that they are located in the continents of Oceania (New Zealand and Australia), Europe (Sweden, Finland and England), East Asia

(China), and North America (Canada).

It is noteworthy that five institutions are located in two countries (Australia and New Zealand) in the continent of Oceania. This may be because Australia and New Zealand rank first and second position, respectively, among the economies that appear as a reference for sustainable tourism (Bruyn, 2014).

In an overview, the mentioned institutions offer graduate courses, master's and PhD degree programs in the field of sustainable tourism.

In the analysis by institution, Griffith University has the highest number of link strengths and, consequently, it attracts the largest number of partnerships. This university was the first institution in Australia to offer courses in Tourism and Hotel Management and it has become a reference in the field. Currently, it offers a bachelor's degree in International Tourism and Hotel Management and a master's degree in International Tourism and Hospitality Management, which aim to train human resources in international tourism and hotel management.

Another institution with the highest number of link strengths is Canterbury University. It is located in New Zealand and the institution offers human resources training courses, particularly in Tourism Management, and the professors and students focus on developing different research studies on conservation and tourism.

Table 7. Centrality and density measurements of the scientific production network in Sustainable tourism, 1990-2018.

Network metric	Network of average	Featured institution
Intermediation centrality	-	Griffith Univ; Univ Canterbury
Centrality degree	11,76%	Griffith Univ; Univ Canterbury
Flow of intermediation centrality	5.97%	Griffith Univ; Univ Canterbury;
Density	51%	-

*Source: Research data*

Based on the analysis of network metric, Griffith University and Canterbury University play a major role in the transmission of information, given that they have greater representativity in the intermediation centrality measure. It should be noted that these institutions are a bridge for peripheral actors in the network to connect to them.

Amid these discussions, the centrality degree index of the network (11.76%) shows that the probability of all institutions accessing all that is circulating in the network is low (Table 7).

When analyzing the centrality degree index, Griffith University and Canterbury University have the greatest number of ties and therefore play a key role in the collaboration network structure of Sustainable Tourism, as it is a link between the institutions. The flow of intermediation centrality shows that the importance of these institutions is not restricted to the number of direct contacts they maintain, but the number of contacts they intermediate. Thus, these institutions are important intermediary agents for the development of knowledge in the field of sustainable tourism. On the other hand, the Chinese Academy of Sciences has no ties with the other universities mentioned in this study. In a detailed analysis



of collaboration of the Chinese Academy of Sciences, this dynamic may be explained due to its greater cooperation with universities located in East Asia, which suggests that geographical proximity plays an important role in facilitating interaction among Chinese researchers.

The collaboration network under study has a density of 51%, indicating good connectivity (Carpenter, Baver & Erdogan, 2009).

In the analysis of the cluster, Griffith University maintains a cooperation pattern with other institutions located in the European continent. As for Canterbury University, a partnership pattern was observed with institutions in the Asian, European and African continents.

By correlating the institutions of the authors with the largest number of publications (Table 5) and the institutions with the largest number of publications (Table 6), we found that only the University of Waterloo and Queensland University belong to both scenarios. From this perspective, the dynamics of collaboration in the field of sustainable tourism is not due to the most prolific authors, but rather due to several authors who promote interaction in the co-authoring network. This perspective enables us to understand the importance of weak ties, which enable researchers with different characteristics (language, geographical location, etc.) to be connected to a theme and expand the knowledge network as well as create new research opportunities (Granovetter, 1973, 1983; Castells, 2018). Regarding the strong ties, most cited institutions and authors in this article are key elements for the development of scientific collaboration network in the field of sustainable tourism, as they assist the weak ties and provide theoretical support for research.

## **4. Conclusion**

Based on what has been discussed, scientific production is based on the economic pillar, particularly regarding the terms of sustainable tourism, tourism, management, sustainable development, sustainability, ecotourism and conservation. On the other hand, there are gaps in the literature regarding the themes related to 'funding' and 'legislation' included in the transverse pillar.

Irrespective of the scope of the research, the most productive authors cited in this study are the most representative ones in the field of sustainable tourism. As for the most cited authors, studies that have adopted a theoretical framework and definitions are top on the list.

As for the collaboration network structure, Griffith University and Canterbury University are the ones that expedite the transmission of information and mediate knowledge in the network under study.

Among the institutions analyzed, the Chinese Academy of Sciences is noteworthy, although it is not among the most productive institutions, because it has an intense cooperation pattern among institutions in East Asia. However, no centrality index scores were found for the Chinese Academy of Sciences and, consequently, it does not cooperate with the other institutions in this study. Thus, it is interesting to note that this institution maintains almost exclusive partnerships with universities located in East Asia. This suggests that this institution relies on geographical proximity as an element for structuring knowledge.

The data allow us to conclude that the scientific collaboration network in the field of sustainable tourism is characterized by good connectivity (density) and geographical proximity.

We suggest further studies to investigate the collaboration network of the most cited authors to

better contextualize the development of scientific knowledge in the field as well as to verify the dynamics of scientific production in 'sustainable tourism' in countries located in the Asian continent, particularly China due to its increasing participation in scientific production, as we have discussed in this article.

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## **Nurses in the front line of the combat to Covid-19 in the hospital environment: related experience**

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## **Abstract**

**Objective:** to report nurses experiences at reference hospital in the care of patients diagnosed with COVID-19 in the state of Sergipe, Brazil. **Method:** descriptive study, of the experience report type, about nurses' experience in assisting patients diagnosed with COVID-19 in the hospital environment. **Results:** The nurses' experiences were structured into three categories: Structural and organizational changes in the hospital service; Nurse's work routine on the front line in the respiratory area; Main difficulties for nurses in caring for patients in the respiratory area and experienced opportunities. The positive aspects identified were participation in training and support for newly hired professionals. **Conclusion:** the COVID-19 pandemic changed economic, political, social and health care behavior. In addition, changes in the hospital environment demanded a reorientation of workflows, impacting nurses' mental health and suffering.

**Keywords:** Coronavirus infections; Pandemics; Hospital Nursing Service.

## **1. Introduction**

With the advent of the SARSCoV-2 pandemic, in March 2020, there were significant impacts on society, economics and politics worldwide, as well as changes in the way health care is produced, which go beyond the context Restroom. Above all, the simultaneous occurrence and the implementation of new measures for the control of the disease that greatly interfere in the organizational dynamics of the Countries with regard to consumer relations (WHO, 2020; Velavan; Meyer, 2020).

The consequences of the spread of SARS-COV2 and COVID-19 are wide-ranging in scope in the short, medium and long term, and have been imposed as new challenges for governments and society. They are worrisome for several reasons, including because they highlight the limits of globalization and scientific and technological advancement (Sarti et al., 2020).

In Brazil, the increase in the number of serious cases and in the mortality of people affected by COVID-19 makes the public health panorama even more worrying. The Brazilian health care scenario has limitations resulting from the increased prevalence of chronic non-communicable diseases, population aging, disease outbreaks and reemergence of communicable diseases such as dengue and measles (Batista et al., 2020).

Thus, with this more demand, the operationalization of surveillance systems often works under pressure, in the need to provide quick, effective and timely responses to the various situations imposed by this new epidemiological scenario. In order to understand the pattern of the disease in the municipalities and in order to support decision-making within the scope of health management (Andrade et al., 2020).

At the same time that the health systems and the economy of several countries advance and collapse, this pandemic has given rise to painful reflections, as it causes thousands of human losses and shows the vulnerability of individuals due to the rapid contagion or the low specificity of prognosis and therapy. Which succumbs to the need for actions aimed at better preparation, coordination and monitoring of these cases in health services (Davidson; Szanton, 2020).

In addition, in general, the mental health of health workers is affected in the current pandemic context. Health professionals deal with psychological stress on a daily basis, as a result of preventive measures and health care for people affected by COVID-10, in an uncertain scenario and of such constant pressure that it has favored illness due to anxiety and depression (Bohlken et al., 2020).

Given this context, this study aims to report experiences of nurses working in a reference hospital in the care of patients diagnosed with COVID-19 in the state of Sergipe, Brazil.

## **2. Methodological Procedures**

It is a report of nurses' experience in direct care for patients diagnosed with COVID-19 in the hospital environment. This medium complexity hospital unit is part of the health care network in the state of Sergipe and provides intensive care beds for people with COVID-19. The reported experiences reflect the experiences, experiences and reflections of nurses from the date of declaration of the pandemic by the WHO (March 17, 2020) until mid-June of that year. It is worth mentioning that in this study there was no need to apply and accept the Free and Informed Knowledge Term, as it is an experience report.

## **3. Results and discussion**

This article is based on the report of nurses who are at the forefront of care for patients with COVID-19. The following categories are presented and discussed: 1) Structural and organizational changes in the hospital service; 2) Nurse's work routine on the front line in the respiratory area; and 3) Main difficulties in caring for patients in the respiratory area and experienced opportunities.

### ***Structural and organizational changes in the hospital service***

In the scenario of the absence of a vaccine for SARS-COV-2 and specific pharmacological treatment for COVID-19, as proven effective and effective recommendations to reduce the transmission of the virus are physical distance, use of face masks, eye protection and washing / sanitization of hands. Thus, the social

isolation imposed by administrative decrees was one of the actions to confront the COVID-19 pandemic in Brazil. In addition to this, emerged and organizational changes were instituted in the hospital environment, registered in March 2020, so that faster control responses could be provided to the population (Derek et al., 2020).

It is noted that the incidence rates are dynamic worldwide, requiring constant and rapid rearrangements and reassessments in the face of the public health scenario, the severity of the disease and its virulence character (Velavan; Meyer, 2020). In this sense, although it was an emergency situation already expected in that hospital, these changes occurred and organizational were implemented in an incipient, vertical and normative way, in less than twenty-four hours, which required health professionals to quickly adapt to this new work process.

The first major structural change occurred in the flow of hospital bed management and was based on the adequacy of the clinical division of users by pathology. Before the pandemic, the inpatient sector was divided into two areas: one for clinical hospitalization, the majority of patients with chronic diseases, and another for care and hospitalization of surgical patients who could be in pre or postoperative, mostly elective surgeries. However, after the pandemic was decreed, the hospital's management allocated the area of clinical internment to the care of people with a suspected or confirmed diagnosis of COVID-19. Two new large areas were created: one for patients with respiratory symptoms and another for the assistance of hospitalized users without respiratory symptoms.

An international study carried out by Singhal (2020), analyzed the structural and organizational changes in bed flows for patients affected by the disease, one of which is the obligation to report confirmed cases to local health regulatory agencies. He also spoke about the institution of conducts that aim to reduce the transmission of the virus among hospitalized patients, since they are already immunologically compromised and, therefore, with a greater predisposition to the spread and contagion by other diseases, including by COVID-19.

### ***Nurse's work routine on the front line in the respiratory área***

Recently, some actions in the unit's work routine were specified in the care and safety protocols adopted by the service as being exclusive to nurses, such as swab collection for COVID-19 tests and laboratory tests such as blood counts. These activities, formerly the responsibility of the laboratory's employees, were redistributed to the nurses of the unit after the reduction in the number of employees, which is yet another measure for infection control. The demands related to the management of the unit, which were already considered private to the nurse and included the organization and planning of actions, also became more numerous and started to be carried out electronically, in order to reduce the printing of medical records and optimize the time in decision making for referrals in care management.

Currently, the work routine of the assisting nurse in the inpatient unit has been basically the following: when entering the service he is directed to the pharmacy sector, where he receives a kit of Personal Protective Equipment (PPE) containing a surgical mask, a N95 mask, a face shield, a hat, a waterproof apron, a cloak, a pair of thongs and two pairs of gloves. PPE is essential material, however, sometimes made available incomplete or even damaged, which is an important obstacle to patient and worker safety from the perspective of risk management. This situation does not observe the national



normative and legal frameworks for the protection of workers, as well as enhancing professional stress due to the imminent risk of contamination and transmission to SARSCOV-2 / COVID-19 family members.

After the moment of systematization of care in the planning of priority actions, the visit to the bed begins with the assessment of hospitalized users (bed run), essential for the management of care, clinic management, risk management and patient safety. Life maintenance care such as bathing, providing food and other measures that meet the basic needs of the human being are the responsibility of the nursing team, under the supervision of the nurse, and were usually performed in the presence of the companion, who assisted in communication possible complaints or complications with the patient quickly. However, the presence of companions was forbidden to avoid crowding people, thus increasing the workload of the nursing team.

It is a context that aggravates the existing work overload, while increasing the vulnerability of these professionals, which can generate consequences beyond physical condition and contribute to problems related to mental health. As corroborated by a study by Allsopp and collaborators (2020) about the mental impact resulting from a major disaster, it has a devastating effect, which can extend over a long period of time, when compared to physical injuries. It is, therefore, evident the potentialization of the work overload of nursing professionals over working hours that vary from 6 to 12 hours. And, pointed out by another research (Luo et al., 2020) that the psychological impact on health professionals due to the COVID-19 pandemic includes increased anxiety, depression, panic attacks or psychotic symptoms.

### ***Main difficulties in caring for patients in the respiratory area and opportunities experienced***

Several difficulties were observed related to the nurse's work process in healthcare practice, including the emergence of conflicts between members of the nursing team or even among members of the multidisciplinary team. Most of the time, these conflicts were related to the lack of standardization of the activities of each social actor in the production of care in the hospital organization. Linked to this, the occurrence of losses in the communication and integration of team members due to the fragmentation of the assistance offered, as a result of the tension generated by the lack of knowledge about the disease and the deficit in training and in the quality of training provided by management.

Added to this is the dynamism in changing protocols for user management with COVID-19, since changes have been made daily, without time to assimilate them. The redirection of care and organizational work processes requires collective effort, in the sense of constantly (re) evaluating and restructuring them and, consequently, of ensuring the safety of patients and nursing professionals (Moraes et al., 2019).

The working conditions offered to professionals who are at the forefront of the care of patients with COVID-19 were precarious and result from the architectural inadequacy and the uninterrupted use of PPE. In this way, basic needs (drinking water, food and eliminations) are compromised by structural barriers (unavailability of a bathroom or drinking fountain) in the inpatient area and by the fear of contamination at the time of eviction.

The working conditions imposed on professionals who are at the forefront of caring for patients with COVID-19 were also the object of criticism, due to the frequent deprivation of basic human needs, in the absence of an adequate infrastructure in the inpatient unit (Oliveira et al., 2020). Associated with the

fear of contamination at the moment of deparation, a difficulty that influences and compromises the fulfillment of your needs.

The number of recommendations for increasing patient safety and containing the transmission of the virus has increased, as has the number of hours worked. These elements, together, aggravate stress and anxiety and contribute to the deterioration of the mental health of these professionals, who, in addition to the fear of contagion, fear to transmit the virus to their families.

In this context, there have been frequent reports of fear, anxiety, tachycardia, sleep deprivation before shifts and burnout, as well as uncertainty and insecurity, not only during work, but also at home, due to the risk of contamination of family members. Thus, many nurses moved away from family life during this period in the name of the safety of loved ones, however, aggravating mental suffering in favor of the profession and permanence in employment. On the other hand, also in this moment of fears, uncertainties and deprivations of professionals, some opportunities have emerged, for example, training and the possibility of sharing information and knowledge with newly hired professionals. There was also the management of new technologies, hitherto not used in the hospital environment, and the experience of the invaluable experience of helping others and fighting for a collective good.

#### **4. Conclusion**

The COVID-19 pandemic imposed behavioral, economic, political, social changes and also in the scope of systems and health care. In addition, the measures implemented in the hospital environment due to the pandemic required a complete reorientation of workflows, in order to provide faster and more effective responses. Such organizational and health care changes have strengths and weaknesses related to the work process of the nurse who works at the forefront of combating COVID-19 in the hospital environment.

The work of nurses / nursing staff, which is usually invisible and little valued in society, currently has the opportunity to be recognized for the care provided at the bedside and the management of health actions in care management. In the international year of nursing, in which Florence Nightingale's bicentenary is being celebrated, we are finally witnessing the strengthening of the role of the nursing team. In this pandemic scenario, professionals can claim appreciation and better working conditions, as society has had contact with the specificity of nursing professionals' actions, which is essential for human beings.

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# **Performance assessment and sustainability of Civil Society Organizations: quanti-qualitative theoretical contributions**

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## **ABSTRACT**

*This article presents the results of a quanti-qualitative research process that introduces a theoretical model of sustainability assessment of non-profit Civil Society Organizations (CSO), SACSO, within the tertiary sector. The theoretical model, in the quantitative approach, is composed of performance assessment indicators, efficiency and efficacy metrics, and a cash flow generation matrix (CGM) by applying basic matrix algebra. In the qualitative approach, the model encompasses indicators of satisfaction and social integration. In both approaches, the evaluation is separated by project, both individual and joint, taking into consideration each project's independence and autonomy. The evaluation process is executed within the context of a governance commitment that uses voluntary service and offers non-state public services. The answers of the model, tested with academic data, anchor robust and meaningful contributions to the literature of sustainability assessment of tertiary sector organizations. Lastly, considering that the results obtained with standardized financial and accounting statements may hinder the model's potential, it is encouraged that empirical research is conducted with managerial data.*

**Keywords:** Sustainability. Operational Performance. Cash flow generation matrix. Civil Society Organizations. Governance and non-state public service.

## **1. INTRODUCTION**

This article introduces discussions about a research process, with a quanti-qualitative approach, that presents a theoretical model of sustainability evaluation of non-profit Civil Society Organizations (CSO), SACSO, within the tertiary sector, having as a starting point the commitment to Governance, the Operational Performance (OP) assessment, and the proposal of a Cash flow Generation Matrix (CGM), for individual and joint projects, considering the independence of each project. In general terms, the discussion is aligned with OECD<sup>1</sup> propositions (1960), Article 1 of the Paris Convention, which includes in its objectives the promotion of public policies aiming

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<sup>1</sup> Organisation for Economic Co-operation and Development (OECD).

“to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy”.

In addition to this multilateral statement, the UN<sup>2</sup> (1987, *Our Common Future*, p. 32) expresses another commitment by stating that

“Human progress has always depended on our technical ingenuity and a capacity for cooperative action. These qualities have often been used constructively to achieve development and environmental progress”.

A CSO can be constituted through several legal means like, for example, associations, foundations, class-based workers associations, mutual-help organizations, among others, so as to play a relevant role in the reduction of inequalities, and to contribute to social welfare, as well as to sustainable development.

Performance, in order to indicate the sustainability of a CSO, has as a starting point the capacity to build the mindset for a collective welfare. In this construction, performance and sustainability are the binomial that leads the way towards an organization's success. Performance is assessed so that the level of fulfilment of the goals designed during planning is known, whereas sustainability is analyzed in order to assess the capacity of an Organization to stay in the market, maintaining its activities. It is within this scope that planning is associated with performance and with sustainability, as an instrument of proposition of goals, as discussed by Jackson (2007). Thus, achieving the planned goals, with a satisfactory performance of activities, is what enables a CSO towards sustainability, in short periods of times, in order to reach the long-term horizon, as evaluated by Bell, Masaoka and Zimmerman (2010).

Sustainability is the 11<sup>th</sup> of the 17 goals proposed by the UN (2015), which constitutes the Sustainable Development Goals (SDG). These propositions address, in broad terms, the cities as the space for urban agglomeration, contemplating statements that

“Cities are the spaces where all SDGs can be integrated to provide holistic solutions to the challenges of poverty, exclusion, climate change and risks” and “... where struggle for sustainability ‘will be won or lost’”.

Thus, sustainability is related to ecological, social, operational and financial-economic commitments, in a triple bottom line agenda, as argued by Elkington (1997). Hence, if at least one of these commitments is left unmet, there is no full sustainable development.

The context of this discussion produces the main motivation and concern to present a model of sustainability assessment of Civil Society Organizations, grounded on the operational performance assessment, on governance contributions, and on a cash flow generation matrix, separating projects conducted individually and in a partnership.

The research contributions are relevant for the literature because they combine, in a multiple approach, the efficiency and efficacy of a CSO's operational performance from a cash flow matrix viewpoint, in which the individual activity and each joint project are independent, with a distinct financial planning and sustainability. The model is tested by using data from academic examples for the evaluation of the premises.

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<sup>2</sup> United Nations (UN).



In addition to the introductory section, this article discusses, in (2), performance and productivity, focusing on operational performance, non-state public service productivity, productivity in joint project management, efficiency and efficacy that indicate the sustainability of individual activities and of joint projects; in (3), governance and sustainability, in which is presented the informational content of the model focused on the cash flow generation matrix of the business that is sustainable; in (4), the conclusions where the main research contributions are summarized and presented. Lastly, the references.

## 2. THEORETICAL MODEL OF SUSTAINABILITY ASSESSMENT OF NON-PROFIT CIVIL SOCIETY ORGANIZATIONS (SACSO)

The theoretical model of sustainability assessment of non-profit civil society organizations (SACSO), which is now being introduced, consists of equations for assessing operational performance (OP), non-state public services (nSPS), productivity in the management of a joint project and the cash generation matrix (CGM). All these equations are specified and described in the following sections.

### 2.1 The assessment of the operational performance (OP)

Operational performance is measured within the context of productivity. In the economic approach, productivity is an operational measure related to an organization's installed capacity to produce by cost, in such a way that allows adequate compensation for the investment.

In the context of a CSO, as a non-profit entity, productivity can be assessed by observing the coverage of costs, the supply of non-state public services, and even the fulfillment of each project's purpose, as a proposal of Sustainability Governance. These measures, which indicate a business's sustainable development, are known as operational performance and compose the process of quantitative and qualitative evaluation.

The OP, addressed in the previous paragraph, as a process of quantitative evaluation, is associated to a business's installed capacity, which produces fixed costs to be covered or recovered by the revenue of the activity in the operating breakeven point (OBP). In the OBP, the revenue equals the sum of the fixed cost with the variable cost proportional to the breakeven quantity of each project to indicate sustainability.

In a CSO, the OBP must be calculated individually for each project of individual and joint activities, taking into consideration that each one of them is independent from one other, differently from a secondary sector organization, where the OBP is calculated for the business as a whole. Since the financial resources of each project executed by a CSO follow a work plan, the OBP calculated as a whole causes an erroneous interpretation of performance and sustainability.

**Performance assessment by the OBP.** The calculation model of the OBP uses the variables fixed cost (FC) and contribution margin (CM). The CM, as discussed in the literature, is the difference between the unitary sales price and the unitary variable cost ( $SP_u - VC_u$ ). The answer to the model is given in physical quantity of the product, understood as service or commodity, for each project identified as  $i$ , as shown by the following equation (1).

$$OBP_i = FC_i * CM_i^{-1} > 0; i = 1, \dots, n; CM \neq 0 \quad (1)$$

From the OBP's answer, the revenue volume (Y) that recovers costs, by project, can be observed as shown by the following equation (2).

$$Y_i = OBP_i * SPu_i > 0 \quad (2)$$

This minimum revenue volume is one of the management measures used to evaluate the OP of a production that indicates sustainable development.

Now, from this minimum revenue volume, given by the OBP, it is necessary to calculate the total cost of each project  $[(OBP_i * VCu_i = VC_i) + FC_i]$  and subtract it from the total revenue (Equation 2). The difference between the total revenue and the total cost of each project is the OP, which indicates whether a project is sustainable or not. In order for the project to be sustainable, the equality/inequality of equation (3) must be met. This condition is necessary so that each project has continuity.

$$Y_i - (FC_i + VC_i) \geq 0 \quad (3)$$

To test the application of the model, numerical data from Academic Example 1 are used, so as to evaluate the theoretical premises.

**Academic example 1.** The scenery is composed of three projects, with project 1 having its own resources, project 2 with Government resources, and project 3 with resources from the Market. The work plan for each project is presented in Table 1. Project 1 encompasses a production of 3,000 units of service at a unitary Reference Price ( $RP_u$ ) of R\$ 350.00, with a variable cost of R\$ 951,000.00 and a fixed cost of R\$ 50,094.00; the object of project 2 is for 9,000 units of service at a  $RP_u$  of R\$ 551.00, a variable cost of R\$ 4,932,000.00 and a fixed cost of R\$ 35,070.00; project 3 estimates a production of 5,000 units of service at a  $RP_u$  of R\$ 450.00, a variable cost of R\$ 2,200,000.00 and a fixed cost of R\$ 50,160.00. The values set by the funding bodies for project 2 and 3 only recover the variable cost of production.

**Table 1:** Data from the work plans of individual and joint projects

Project (i)	Q	$RP_u$	VC	FC
Proj 1	3.000	350,00	951.000,00	50.094,00
Proj 2	9.000	551,00	4.932.000,00	35.070,00
Proj 3	5.000	450,00	2.200.000,00	50.160,00

Q=quantity.  $RP_u$ = unitary reference price. VC= variable cost; FC= fixed cost (maintenance and compensation for the investment).

Now, based on the data from Figure 1, the contribution margin ( $CM_i$ ) of each project is initially obtained according to equation (4), and then the breakeven quantities.

$$CM_i = SP_{u(i)} - \frac{VC_i}{Q_i} > 0 \quad (4)$$

The  $SP_{u(i)}$  corresponds to the  $RP_u$  of each project and  $\frac{VC_i}{Q_i}$  is the variable unitary price of each project. The difference between the  $RP_{u_i}$  and the  $VCu_i$  of Projects 2 and 3 is assumed by the CSO.

Once the CM is known, the OPB of each project is calculated. The basic premise of the OP is that the OBP be lower than the total quantity ( $Q_t$ ) of each project so that there is sustainability ( $OBP_i < Q_{t_i}$ ).

### Breakeven quantities of each project

$$OBP_1 = \frac{50,094}{33} = 1518 \text{ units}$$

$$OBP_2 = \frac{35,070}{3} = 11690 \text{ units}$$

$$OBP_3 = \frac{50,160}{10} > 0 = 5016 \text{ units}$$

The answers of the OBP for each one of projects 2 and 3 indicate, at first, that the basic premise of sustainability has been violated because the breakeven quantities exceed the total quantities.

**Evaluating the OP of each project.** Now the metric is for the final result of the project. Thus, for each project  $i$  in which the result of Equation (5) is higher than zero, the project is operationally sustainable, as shown in Table 2. Thus,  $OP_i \geq 0$ , suggests sustainability.

$$OP_i - [RP_i * Q_i - (VC_i + FC_i)] \geq 0 \quad (5)$$

**Table 2:** Evaluation of the operational performance of each project

Project (i)	Total revenue (i)	Total cost (i)	OP (i)
Project 1	1,050,000	1,001,094	48,906
Project 2	4,959,000	4,967,070	-8,072
Project 3	2,250,000	2,250,160	-160

Based on the premises of the model, only project 1 is sustainable because it presents an OP higher than zero, whereas projects 2 and 2 are not sustainable, which corroborates the premises of the OBP. If the CSO executes projects 2 and 3, it reduces the funding capacity of its own activities and, consequently, it becomes less sustainable, which can jeopardize its continuity.

This example reinforces the argument that the performance assessment of a CSO differs from that of a secondary sector Organization. Here, each project must be sustainable independently. Hence, the evaluation must be done individually for each project.

## 2.2 Productivity of non-state public services (nSPS)

Non-state public services (nSPS), as a quantitative obligation, are associated to the commitment of a CSO to offer society a quantity of services equivalent, at least, to the quantity of benefits this CSO gets from the State, through direct or indirect transfers. Generally, every non-profit CSO is a tertiary sector organization benefited with indirect transfers of tax exonerations, through immunity and/or exemptions, which is called tax break (TB).

What is observed in Brazil is that the State is not present to inspect whether the obligation to offer nSPS by a CSO is being met, except when it comes to a CSO whose business purpose is the provision of services in the areas of social assistance, healthcare or education, for which is granted a Certificate of Beneficent Social Assistance Entities (CEBAS), but only when it comes to the TB of employer contributions for social welfare.

One of the metrics to assess whether a CSO gives the nSPS back to society, at least at an equal value to that of the TB received, is presented in the model introduced by Equation (6).

$$nSPS - TB \geq 0 \text{ ou } \frac{nSPS}{TB} \geq 1 \quad (6)$$

To illustrate this situation, the hypothetical data of a CSO are tested based on Academic Example 2.

**Academic Example 2.** A CSO benefited with CEBAS works in the field of education, and the annual sum of the TB referent to the monthly employer contribution to social welfare totals R\$ 480,000.000. The nSPS offered by the CSO must be at least equivalent to the TB value, considering that the CSO receives other benefits of tax exoneration. But the nSPS and the TB are only those associated to a CSO's own individual activities, which does not include any joint projects.

The way to offer a nSPS through a CSO that explores education services is through a study grant. These grants can be given in full amount or partial amount. Thus, consider that a CSO offers, monthly, 30 full-amount grants at a unitary value of R\$ 980.00, plus 22 partial-amount grants at a value of R\$ 490.00 each. Table 3 shows the monthly distribution (M) of the unitary value of each grant and annual value of all grants.

**Table 3:** Monthly unitary value of each study grant and the total of nSPS offered by a CSO

GRANT	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	SUM
												M1
												2
Full	980	980	980	980	980	980	980	980	980	980	980	98 352,800
												0
Partial	490	490	490	490	490	490	490	490	490	490	490	49 129,360
												0
Sum	147	147	147	147	147	147	147	147	147	147	147	482,160
	0	0	0	0	0	0	0	0	0	0	0	14
												70

The column SUM represents the total annual value of the grants offered as a nSPS to society. By applying the metric, the result shows that the nSPS value is higher than the TB value received. This result suggests that the public policy of tax exoneration associated to CEBAS is sustainable.

### 2.3 Productivity in the management of a joint project.

The Brazilian State has established a legal means to regulate partnerships between the public administration and CSOs, in a system of mutual cooperation (Law no. 13,016/2014), as a quanti-qualitative process. Such system has established that partnerships must be formalized through **(a)** terms of collaboration, **(b)** terms of funding, and even **(c)** cooperation agreements.

For each one of these formalized terms, the partnership manager, be it ongoing or finished, must evaluate the efficacy and effectiveness of the actions of the partner CSO by considering the results and

benefits obtained and, mainly, whether there is evidence that the actions are sustainable after the partnership's purpose is concluded.

The manager's evaluation must take into consideration the work plan that quantifies and qualifies the partnership's purpose, from which all actions are executed. So, the work plan quantifies the partnership goals, and the execution reports indicate the status of completion of each goal.

The evaluation of the goals happens quantitatively and qualitatively. It is quantitatively observed through the physical and financial fulfilment of the purpose, while it is qualitatively observed through the evaluation of socioeconomic and environmental impacts, among others.

To analyze the efficacy and the effectiveness, and decide for sustainability, it is necessary that indicators are introduced in order to signal the completeness of said purpose. In this sense, a model of three indicators is proposed, which is composed of **(1) Estimated expenditure per capita (EEP)**, **(2) Realized expenditure per capita (REP)**, **(3) Project efficiency index (PEI)**, **(4) Qualitative evaluation index (QEI)**, and a variable  $i$  that identifies the partnership's project.

**Estimated expenditure per capita (EEP).** The EEP is obtained by the quotient between the estimated project value (EPV) and the estimated project quantity (EPQ). This quotient indicates the project's average resource cost, which is the expected productivity of the partnership.

$$EEP_{(i)} = \frac{EPV_{(i)}}{EPQ_{(i)}} \quad (7)$$

**Realized expenditure per capita (REP).** The REP shows the ratio between the realized project value (RPV) and the realized project quantity (RPQ), and indicates the average cost of the project's execution, which is the effective productivity of the partnership. It is assumed that the project's funding body takes on the totality of resources present in the work plan, resulting in the RPV equal to the RPQ.

$$REP_{(i)} = \frac{RPV_{(i)}}{RPQ_{(i)}} \quad (8)$$

**Project efficiency index (PEI).** The PEI is the quantitative evaluation measure of an individual or joint project. This measure shows the completeness of the goal defined in the work plan and translates efficiency and efficacy in the execution of each project with metrics that indicate whether the project is sustainable or not.

$$PEI_{(i)} = \frac{REP_{(i)}}{EEP_{(i)}} \quad (9)$$

The PEI metrics combine efficiency and efficacy of each project. Thus, each one of them considers that the absorption of resources is constant ( $EPV=RPV$ ), whereas the efficiency and efficacy are results of the coefficient's magnitude.

$$PEI_{(i)} = \begin{cases} 1 \Rightarrow \text{effective execution} \\ < 1 \Rightarrow \text{effective and efficient execution} \\ > 1 \Rightarrow \text{ineffective and inefficient execution} \end{cases}$$

**Definition 1.** The execution of a project is said to be effective if the  $PEI_{(i)} = 1$ . With this metric, the CSO linearly performs the purpose of the work plan ( $EPQ=RPQ$ ) using the totality of resources ( $EV=RV$ ).

**Definition 2.** The execution is said to be inefficient if the  $PEI_{(i)} > 1$ . This metric indicates that the CSO does not fulfill the purpose of the work plan, producing less than what was commissioned ( $RPQ < EPQ$ ) using the same resources ( $RPV=EPV$ ).

**Definition 3.** The execution is said to be efficient if the  $PEI_{(i)} < 1$ . This execution indicates that the CSO overachieved the goal defined by the work plan ( $RPQ > EPQ$ ) with the same resources ( $RPV=EPV$ ).

**Definition 4.** The Project is sustainable if the  $PEI_{(i)}$  is at most equal to 1, a metric that translates efficacy or efficiency. As the model shows, efficacy comes from fulfilling the commissioned purpose, in its entirety, and efficiency translates gain in productivity with the same resources. Thus, the sum of these attributes, efficacy and efficiency, generates synergy that gives the project sustainability.

**Qualitative evaluation index (QEI).** The QEI, as a qualitative measure, is a combination of the percentage of satisfaction (PSA) with the percentage of socialization success (PSS). The PSA is the quotient between the satisfied quantity of the project (SQP) and the RPQ. The PSS is the quotient between the quantity of the project put on the market (QPM) and the RPQ. Thus, a QEI approaching 1 indicates that the partnership is qualitatively sustainable.

$$PSA_i = \frac{SQP_i}{RPQ_i} \quad (10)$$

$$PSS_i = \frac{QPM_i}{RPQ_i} \quad (11)$$

$$QEI_i = PSA_i * PSS_i = \frac{SQP_i * QPM_i}{RPQ_i^2} \equiv 1 \quad (12)$$

The premises of qualitative sustainability are evaluated considering the data from Academic Example 3, in which a CSO receives direct transfer of a State Body to provide training to young people with skills for the assistance to the elderly.

**Academic Example 3.** A CSO established a partnership with a Government Secretariat to train an EPQ with 250 young adults between the ages of 20 and 25 with specific skills to care for the elderly. The partnership has a one-year term and the EPV is R\$ 1,250,000.00. By the end of the partnership, they will assess efficacy, efficiency, and project's sustainability by quantitative and qualitative criteria.

The assessment's results are important for the Secretariat to decide on future partnerships with the CSO. The RPQ of trained young people is 260. The data from the work plan and the results of the project's execution are shown in Table 4.

**Table 4:** Data for the quantitative and qualitative evaluation of the project

Partnership	EPQ	EVP (R\$)	RPQ	SQP	QPM
Work plan	250	1,250,000			
Execution Report		1,250,000	260	260	255



Now, by applying the model described in Equations 7 to 12 to the partnership data, the results shown in Table 5 are found.

**Table 5:** Indicators from quantitative and qualitative evaluations of the project

Indicators	Equation 7	Equation 8	Equation 9	Equation 10	Equation 11	Equation 12
EEP	5,000					
REP		4,808				
PEI			0.9616			
PSA				1.000		
PSS					0.9808	
QEI						0.9808

The answers to the model indicate that a CSO produces more than the required by the work plan, with the same resources, and, thus, presents a REP lower than the EEP. This performance translates efficiency and efficacy in the execution of the partnership because the PEI is lower than 1, indicating that the project is sustainable.

### 3. GOVERNANCE AND SUSTAINABILITY

Governance and sustainability are a binomial of reciprocity. Sustainability needs an effective Governance, and Governance promotes sustainable development. So, a sustainable CSO is one with efficacy in Governance and management.

#### 3.1 Governance

The terminology Governance has lately been used to denote the capacity to govern in a rational, participative, and democratic manner, as addressed by Lafferty (2004), and constitutes one of the means to achieve sustainability, as a quanti-qualitative process. A non-profit CSO, by nature, has a democratic characteristic, in which decisions are made in a collegiate, pluralist, and participative manner. In this context, the OECD (2001) emphasizes the relevance of the human capital stock and the social capital stock associated with Information and Communication Technologies (ICT), which allow for the interaction between individuals, communities, organizations, and society to produce welfare and sustainable development.

For the OECD, human capital in the context of Governance is addressed as

“Human capital is the familiar notion that knowledge and skills, derived from education, training and experience, represent some of our most valuable resources”

because it includes knowledge and abilities, and it represents an investment with economic and financial return that raises employment rates and gains.

Social capital, in this same approach, represents the relationship inter- and between groups, in the contexts of rules and values that promote cooperation. This capital is multiplied in networks in the interaction between people.

Corroborating these conceptual approaches, Renz & Smith (2010) assess that Governance should be performed through a Council with legal authority to exert power over the other members of the Organization, observing the principles of legality and of ethics. Even if they are not in the Organization's routine, the members of the Council are trustees of the organization's resources and enthusiasts of the accomplishment of the Organization's mission, giving focus to the vision, values, transparency ethos, conformity, and integrity.

With this understanding of Governance, a CSO's Mission is the focal point for accountability, guarantor for credibility, which justifies its reason for existing and leads to sustainability, even if the CSO benefits from tax exoneration. This takes place because a CSO is constituted to cater to underlying needs not fulfilled by the state, such as caring for ecology and caring for the basic needs of vulnerable people, among others. Thus, the Mission must be in the focus of strategic planning and financial planning embodied in a cash flow generation matrix, in the service of the objectives that the Organization has chosen to pursue.

### 3.2 Sustainability in a comprehensive context

Sustainability is an attribute observed in the context of sustainable development, in which the UN (1987), in *Our Common Future* (p.37), states that

“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

and that this development promotes progressive transformations of the economy and of society in order to meet individuals' basic needs through productivity.

Still in *Our Common Future* - UN (1987-p.32), the authors pose the question of “How long can we go on and safely pretend that the environment is not the economy, is not health, is not the prerequisite to development, is not recreation? Is it realistic to see ourselves as managers of an entity out there called the environment, extraneous to us, an alternative to the economy, too expensive a value to protect in difficult economic times?” But the answers to these questions are not yet given.

One of the difficulties to give these answers is possibly that different political actors seem to ignore and deny that life is being degraded by predatory action against nature. Pragmatic denial, which ignores science, ignores evidence of the destruction of forests and springs, while it neglects education, maintaining people in the poverty of ignorance that directly affects sustainability.

The literature has presented us with relevant discussions on the agenda of the United Nations for the fulfillment of the planet's sustainability goals. Immersed in this discussion, Holden, Linnerud & Branister (2014) analyzed the combination of four goals that they named primary dimensions, derived from *Our Common Future* - UN (1987), with four social indicators. The authors stated that they used a sample of 167 countries, in the period spanning 2008 and 2009, and the result of the combinations indicates the fulfillment of the goals between 8.98% and 36.53% in relation to the total of each of them. The results are tentative, but the deadline for the complete fulfillment of the agenda is set for 2030.

### 3.3 Sustainability in the context of the cash flow generation matrix (CGM)

The sequencing of the CGM of a CSO, as a consequence of operational performance, is the challenge of the sustainability of the business that imposes a dynamic manner of evaluating each project within the scope of the Organization.

A CSO's cash flow generation differs from the cash flow generation of an Organization in the primary and secondary sectors. An Organization of the primary sector generates cash flow through the compulsory financial obligations of each taxpayer through the payment of taxes. An Organization of the secondary sector generates cash flow through the production of goods and services in demand by consumers.

A CSO's CGM is a dynamic instrument of financial management stemming from its own sources, from financial transfers from partnerships and from donations, which materializes cash flow separately, by project. This instrument allows for the monitoring of the fulfillment of the objectives and goals planned in the financial budget, and thus must be the object of special attention from Governance, for the maintenance of the Organization's activities. In assessing this context, Linzer & Richard (2008) argued that

*“Predicting cash flow is important because it requires a comprehensive understanding of all strategic elements faced by a non-profit institution... If ensuring profitability is a classic test for the CEO of a trade company, then accurately predicting the cash flow of a non-profit institution is a comparable skill in the non-profit world.”*

As a dynamic instrument for financial management, the CGM contributes to a holistic view of financial budgeting and planning for cash flow management. But, considering that a CSO does not aim for profit, **one poses the question:** where do the resources feeding its cash flow come from? The **answer** to this question considers that the cash flow generation sources for a non-profit CSO are **(a)** proprietary activities, such as income from the sale of services and/or commodities; **(b)** financial transfers of activities in partnership with the State and/or with the Market; **(c)** financial transfers received in voluntary donations; and **(d)** income from assets.

Another question that may disquiet the reader is why use a CGM and not the traditional cash flow that is widely known by most managers. The answer to this question is given in the following three stages.

**First.** A CSO's cash flow management is done through projects, and one project is independent from another. For this reason, the leftover funds from a solvent project cannot rescue the insufficiency of funds for an insolvent project. This manner of cash flow management differs from an Organization of the primary and secondary sectors.

**Second.** A CGM results from basic matrix algebra of addition of matrices of cash inflows and outflows, whose elements represent each project, by unit of time. Cash inflows are distributed in a matrix named  $C^+$  and cash outflows in another matrix named  $C^-$ . So,  $CGM = (C^+ - C^-)$  is the cash balance of each project in each unit of time.

**Third.** The focus is objectivity and simplicity in the visualization of the cash balance represented by an element of the matrix that identifies each project in its respective unit of time. This balance indicates whether the projects are solvent or not for each time unit. If solvent, the project is sustainable; if not, the project is non-sustainable, a situation in which governance and the managers must negotiate time and resources to honor their commitments.

But, before moving on, it is important to clarify the use of matrix notation. The properties of a matrix are varied, and we do not intend to explore them here. The use of matrix notation is solely for the reading of each element of the matrix that represents cash balance individualized by project per unit of time, in a dynamic manner.

So, for the algebra of the CGM to indicate the dynamics of a project's cash flow in a period of time, it is necessary that indexes are attributed, which form the *elements* of each matrix to indicate the project and the unit of time to which each one of them makes reference. Thus, the letters *i* and *j* are attributed, in subscript, to each of the elements of the matrices to denote this dynamic, such as  $C_{(i,j)}^+$ ,  $C_{(i,j)}^-$ , and  $CGM_{(i,j)}$ . From now on, *i* represents each project, and *j* represents each unit of time (day, month, year, etc.).

The matrix model and representation are thus defined.

### Model

$$CGM_{(i,j)} = [C_{(i,j)}^+ - C_{(i,j)}^-]; \quad i = 1, 2, \dots, n; \quad j = 1, 2, \dots, n; \quad i = j \text{ ou } i \neq j$$

### Matrix notation

$$CGM_{(i,j)} = \begin{bmatrix} CGM_{1,1} & CGM_{1,2} & CGM_{1,3} \\ CGM_{2,1} & CGM_{2,2} & CGM_{2,3} \\ CGM_{3,1} & CGM_{3,2} & CGM_{3,3} \end{bmatrix}; \quad C_{(i,j)}^+ = \begin{bmatrix} C_{1,1}^+ & C_{1,2}^+ & C_{1,3}^+ \\ C_{2,1}^+ & C_{2,2}^+ & C_{2,3}^+ \\ C_{3,1}^+ & C_{3,2}^+ & C_{3,3}^+ \end{bmatrix}; \quad C_{(i,j)}^- = \begin{bmatrix} C_{1,1}^- & C_{1,2}^- & C_{1,3}^- \\ C_{2,1}^- & C_{2,2}^- & C_{2,3}^- \\ C_{3,1}^- & C_{3,2}^- & C_{3,3}^- \end{bmatrix}$$

The difference between the elements of the matrices of cash inflow and outflow forms the elements of the  $CGM_{(i,j)}$ . In this arrangement,  $i=1$  identifies project 1;  $i=2$  identifies project 2; and  $i=3$  identifies project 3. In the same manner,  $j=1$  identifies month 1;  $j=2$  identifies month 2; and  $j=3$  identifies month 3. In this notation, all matrices are composed of three lines and three columns, and thus, in this format, they are named 3x3 square matrices.

Given that what represents the matrix notation is known, consider the academic observations laid out in Table 6, in which a given CSO operates with three projects (i) and planned its cash flow based on a financial budget for three months (j) starting in January. Each project corresponds to a source of cash flow, and each month is a unit of time. Thus, in total,  $i = 3$  and  $j = 3$ .

**Table 6:** Academic observations of cash inflows and outflows from January to March.

<b>Source 1 linked to project 1</b>	Inflows	Jan R\$ 220	Feb R\$ 210	Mar R\$ 150
	Outflows	Jan R\$ 205	Feb R\$ 215	Mar R\$ 140
<b>Source 2 linked to project 2</b>	Inflows	Jan R\$ 600	Feb R\$ 510	Mar R\$ 750
	Outflows	Jan R\$ 500	Feb R\$ 600	Mar R\$ 760
<b>Source 2 linked to project 3</b>	Inflows	Jan R\$ 130	Feb R\$ 130	Mar R\$ 150
	Outflows	Jan R\$ 120	Feb R\$ 130	Mar R\$ 165

**Informational content of the elements of the CGM.** Each element of the following  $CGM_{(i,j)}$  represents the cash balance of each project *i* at each time unit *j*, which corresponds only to the difference between the inflows and outflows in each period. No unit of time *j* carries over balance from the previous time unit. The first line corresponds to project 1, the second to project 2, and the third to project 3. In the same logic,

the first column corresponds to the month of January, the second one to the month of February, and the third one to the month of March.

$$CGM_{(3,3)} = \begin{bmatrix} 15 & -5 & 10 \\ 100 & -90 & -10 \\ 10 & 0 & -15 \end{bmatrix}$$

In  $j=1$  (column 1), all projects present cash inflows larger than their outflows, showing solvency for that month.

In  $j=2$  (second column), projects 1 and 2 (first and second lines) show negative balance for the month's movements. As there is no incorporation of any previous balance, this shows that the cash inflows for that month are inferior to the respective outflows. Project 3 (third line) is in better condition of solvency, with a balance equal to zero, meaning cash inflows were equal to the respective outflows for the month. This situation does not break the accounting rule stating that the cash balance cannot be lower than zero.

In  $j=3$  (third column), projects 2 and 3 show cash inflows inferior to the respective outflows; project 1 shows the opposite.

Now, considering that  $j=3$  is the last unit of time for each project, the three columns of each project are added to obtain the accumulated balance. In this context, projects 1 and 2 are sustainable because the balance for project 1 is R\$ 20 and the one for project 2 is zero. Project 3 is non-sustainable, because its balance is lower than zero (R\$ -5), thus it cannot be executed.

**Informational content of the elements of matrix  $C^+$ .** The informational content of each element of the matrix  $C_{(i,j)}^+$  is the total of cash inflows of each project identified with  $i$ , in each month identified by  $j$ .

Thus, when  $i = j=1$ , the element is identified by  $C_{(1,1)}^+$  that corresponds to the total of project 1's cash inflows in the month of January.  $C_{(1,2)}^+$  identifies the total of the cash inflows in the month of February, and so on, as shown in the elements of the square matrix  $C_{(3,3)}^+$ .

$$C_{(3,3)}^+ = \begin{bmatrix} 220 & 210 & 150 \\ 600 & 510 & 750 \\ 130 & 130 & 150 \end{bmatrix}$$

The informational content of the first line corresponds to project 1's inflows, the one on the second line shows the inflows for project 2, and those on the third line are for project 3. On the other hand, the informational content on the first column refers to the month of January, the second column to the month of February, and the third column to the month of March. Thus,  $C_{(3,3)}^+$  informs the total inflows for project 3 in the month of March. The sum of all elements of a line indicates the total of the cash inflows for the respective project.

**Informational content of the elements of matrix  $C^-$ .** Similarly to the approach of the previous matrix ( $C_{(3,3)}^+$ ), the informational content of matrix  $C_{(3,3)}^-$  shows the total of each project's cash outflows, and the sum of each line informs the total cash outflow for each project. In this manner, for  $i = j=2$ , the informational

content of the element  $C_{(2,2)}^-$  represents the cash outflow for project 2 in the month of February. If  $C_{2,3}^-$ , the content represents project 2's cash outflows for the month of March and so forth.

$$C_{(3,3)}^- = \begin{bmatrix} 205 & 215 & 140 \\ 500 & 600 & 760 \\ 120 & 130 & 165 \end{bmatrix}$$

In sum, the use of matrices to demonstrate the evolution of a CSO's cash flow does not intend to explore other properties other than exhibiting, in a dynamic manner, the cash inflows, outflows, and balance for each month, maintaining the independence of each project.

### 3.4 The capillarity of voluntary work in sustainable development.

Volunteer work is a relevant source of resources to foster a CSO's activities. Even if voluntary work does not involve money, it is a force that saves financial resources that fund primary and ancillary activities and contributes to sustainability. One of these work forces is identified in Governance, a structure that gathers capacities and abilities of people that dedicate themselves in a dative manner, allocating their time and knowledge to promote the welfare of others.

In ancillary and principal activities, one identifies the voluntary work that acts in the realization of a CSO's business purpose, leveraging the production of welfare, such as promoting healthcare services for the elderly and children, as well as in the social assistance given to vulnerable people, and in the conduction of administrative processes.

The CSO that receives voluntary work must measure it and allocate it in the cost structure of the corresponding primary or ancillary activity, according to market value. Professional categories do not always divulge the hourly price for labor. For the adequate measuring of this labor, the CSO must consult the volunteer workers as to what the price of their labor would be if they were paid, and, from this price, conduct the allocation in the cost structure.

The adequate pricing of voluntary work contributes to the process of accountability and transparency in the quantitative and qualitative disclosure of information, especially when referring to the offer of non-state public services by the CSO. Accountability and transparency are relevant attributes in the accreditation of a CSO, and they contribute significantly to sustainability.

So, how does one measure and allocate voluntary work into a CSO's cost structure? This question can be answered in more than one way. In this study, we suggest the following:

- The CSO must sign a document with the volunteer worker, detailing the nature of the service provided, the amount of service, and the waiving of payment.
- The CSO must obtain the unit price for the labor with the worker or in the active market for this service.
- The CSO must draft a spreadsheet that prices the labor as if payment were owed, and allocate it to the cost center where the volunteer worker works.
- The CSO must recognize, in its accounting, the value of the priced work and disclose it in its financial statements.

Brazilian regulation establishes that the state does not possess the right to any social security taxes, or any other taxes on voluntary work. This regulation is an assurance that voluntary work will not produce



liability or financial cost to the CSO. In this context, it must be clear that voluntary work must be used in the benefit of society through the offering of nSPS. Thus, to contribute in a didactic manner to the process of the allocation of the costs of voluntary work in a CSO, we use the data from academic example 4, as follows.

**Academic Example 4.** The context refers to two volunteer workers. A volunteer in the area of healthcare who is available to work 20 hours a month for a CSO, assisting children. The other is available to work 15 hours a month for the same CSO, in administrative accounting services. The hourly price the market would pay for any of these positions is R\$ 500.00. Therefore, the total cost to be allocated to the corresponding field, healthcare, is R\$ 10,000.00, and, to the administrative division, it is R\$ 7,500.00.

These two values must be recognized by the CSO, through the process of accounting records, and divulged to society in financial statements. The disclosure must contemplate the quantity of volunteer workers and their respective inexpensive costs, as well as the contribution of these services to the offer of nSPS.

## 4. CONCLUSIONS

The research presented the process for the sustainability assessment of the of non-profit Civil Society Organizations (CSO), SACSO, making up the tertiary sector, through a theoretical model exploring quantitative approaches.

The quantitative approach of the theoretical model is made up of performance assessment indicators, cash flow generation matrix, efficiency and efficacy metrics so that, as a whole, the fulfillment of each project's object can be assessed. The qualitative approach explores the informational content of the satisfaction and social integration indicators as complementary to the fulfillment of the object.

The model was tested using academic data, and the answers obtained make robust and significant contributions to the literature of the assessment of the sustainability of Civil Society Organizations, because they allow the regulator, based on the model's metrics, to decide reliably and safely.

The results also show the relevance of the governance structure, the contribution of voluntary work, and the supply of non-state public service, as a counterpart to the benefits received by direct and indirect transfers, by a CSO, to society.

Lastly, the use of data divulged in the CSO's standardized financial statements, due to them being consolidated, can limit the model's potential. Because of this possible restriction, we urge empirical assessments to use management data, due to their analytical character, and this characteristic means they can ensure quality and reliability to the decisions of regulators and the contributions of researchers.

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# THE IMPORTANCE OF A TOY IN THE DEVELOPMENT OF CHILDREN WITH VISUAL IMPAIRMENT<sup>1</sup>

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*The educational toy defines itself [sic] as a methodical transmission agent of knowledge and skills that, before its emergence, were not transmitted to children by toys. It symbolizes, therefore, a deliberate intervention in children's leisure in order to offer pedagogical content to the children's entertainment (OLIVEIRA 1984 apud BUENO, 2010, p. 25).*

## Abstract

*This text summarizes a qualitative bibliographic research that aims to discuss what visual impairment is, highlighting the difference between blindness and low vision, as well as highlighting the importance of the toy associated with playing, in the learning of children with Visual Impairment-VI. The exploration of the toy expands the possibilities of the child's development in his/her multiple dimensions, cognitive, psychomotor and social affective, among others.*

**Keywords:** Joke; Learning; Child with Visual Impairment;

## 1. Initial Considerations

The school is the institution of collective character prepared for offering the necessary conditions for the construction of knowledge and development of cognitive, affective, biopsychosocial and psychomotor potentialities, in the different phases of the human being, but notably in childhood, considering that it is the basic period in which the child goes through the process of construction and socialization, so significant for his/her life.

In this sense, it is worth remembering that, "To care is necessary first of all to be committed to the other, with its uniqueness, to be sympathetic to their needs, relying on their abilities. This depends on

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<sup>1</sup> This text was produced from the article "The contributions of the toy in the significant learning of children with visual impairment, of our authorship, published in Eduardo Scheidt; Luis Gutiérrez Sanjúan; Elian Araújo. (Org.). Integration in Latin America from an interdisciplinary perspective. 1ed. Curitiba: Prismas, 2017, v. 1, p. 367-384.

the construction of an affective bond between those who care and are cared for" (RCNEI –Vol. 1, p. 75, MEC/SEF, 1988).

In historical terms, it was from the 17th century that schools were considered as a place where everyone, teachers and students, transmit and acquire new knowledge and are in a constant learning process, and teachers are conceptualized as mediators of this new knowledge. The school is very important in the lives of all students, being, therefore, one of the main ways to mediate the relationships and interactions between students-students/students-teachers, thus promoting new significant learning in the lives of both parts.

Taking a leap to contemporaneity, currently, schools are experiencing a process of major changes and adaptations, to receive students with Special Educational Needs – SEN, and today these students have the right to guarantee their enrollment in the public school system and these schools must be prepared to receive such students and assist them in the teaching-learning process.

Based on these considerations, this research seeks to discuss what visual impairment is, highlighting the difference between blindness and low vision, as well as highlighting the importance of the toy associated with playing, in the learning of children with Visual Impairment-VI. In this direction, the notion of an inclusive education is also discussed and is imperative to the contemporary scenario, as something naturalized and unquestionable to relations, not only educational, but also social.

It is important to highlight that visual impairment -VI, in the educational context, has undergone many mutations, as well as other deficiencies, conceptions and concepts about Visual impairment have improved over time through school inclusion. The inclusive approach understands that school is an environment common to all, where knowledge is constituted; in inclusive school, all people resemble by their own differences.

## **2. What constitutes Visual Impairment - VI: low vision and blindness**

First, it is necessary to remember that low vision is a disability that needs to be diagnosed as soon as possible, so that the child obtains better development conditions, and in the school environment, this child will need the proper use of accessibility resources for students with this disability.

In terms of classification, blindness is seen in two groups: a) congenital blindness and b) acquired or adventitious blindness. Congenital blindness is particularly defined by the lack of vision, a fact that can occur from birth to five years. Acquired blindness is evidenced by vision loss at any stage of life, which may be due to some infectious diseases, systemic diseases or traumas.

The degrees of vision cover a wide spectrum of possibilities: from total blindness to perfect vision, also total (GIL, 2000). The expression "visual impairment" refers to the spectrum that goes from blindness to subnormal vision. Visual impairment is understood in two distinct groups: a) blindness and b) low vision, as Bruno (1997, p. 07) points out, from the educational point of view, these groups are characterized as:

Blind people, who present 'from total absence of vision to loss of light projection', whose learning process will take part through the integration of the senses: tactile-sinesic- auditory-olfactory-gustatory, using the Braille System as the main mean of reading and writing.

People with low vision, who present 'from conditions to indicate light projection to the degree to which the reduction of visual acuity interferes or limits their performance'. The educational process will be developed by visual means even if the use of specific resources is necessary.

From the medical perspective, Visual Impairment-VI is identified according to the International Statistical Classification of Diseases and Related Health Problems (ICD-10), the description of VI uses as indicators the values of visual acuity and visual field.

Low vision consists of a significant change in the functional capacity of vision, resulting from some factors, such as lowering of visual acuity, significant reduction of the visual field, changes in color vision and sensitivity to contrasts, which interfere with or limit visual performance (HONORA AND FRIZANCO, 2008). In the educational field, the student with low vision is the one who has useful vision for the purposes of the classroom, but who needs optical aids (glasses, magnifying glass, lenses, among others) and magnifications to read and write.

Low vision results in visual impairment of both eyes, making it difficult to perform the daily routine of some individuals, which can be improved with the help of optical and non-optical aids. In Sierra's view (2011, p. 36-37), such aid can be defined as:

Optical aids: glasses with special lenses: spartoprismatic, microscopic, bifocal or monofocal; hand, table, support, neck and illuminated magnifying glass.

Non-optical aids: enlarged materials (books, texts, games, handouts, etc.), inclined plane for reading, adequacy of the environment (natural lighting, use of lamps that provide greater clarity to the environment without the incidence of reflection, use of yellow acetate to reduce clarity and reflection on paper), materials that assist in better visualization (4B or 6B pencils, porous tip pens, notebooks with bold staves and with greater spacing between lines, type scopes, word separator) and electronic and computer equipment (closed circuit television - CCTV, apparatus that, coupled to a television, often enlarges the image and transfers it to the monitor, electronic magnifying glass, software that magnify the screen and programs with voice synthesizers).

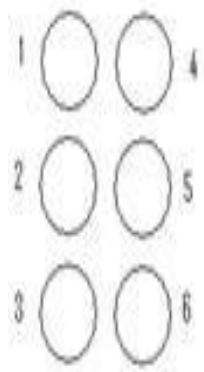
The five senses are naturally fundamental to life, each of them (vision, hearing, smell, taste and touch) has its valuable contribution in the process of relation of the human being, specifically with the environment. Vision, in turn, represents one of these senses and, certainly for the one who has reduced it or is deprived of vision, is the most important meaning, because, as poetically can be referred to, the eyes represent the window of the soul.

Blindness, therefore, results in total loss of vision, it is null, nor is light perception existing; according to some medical experts in the field, the expression zero vision is used to define blindness. In contemporary society, there is a culture in which reading and writing is indispensable and, for people

with Visual impairment - VI and especially blind people to be part of this same culture, the use of the Braille system is essential.

Blind students are literate using the Braille system, which is essential for them to learn to read and write, as Sierra (2011) points out, "[...] being defined as: a universal code of reading and writing for blind people and was created by the French Louis Braille (1809 – 1852) in 1825".

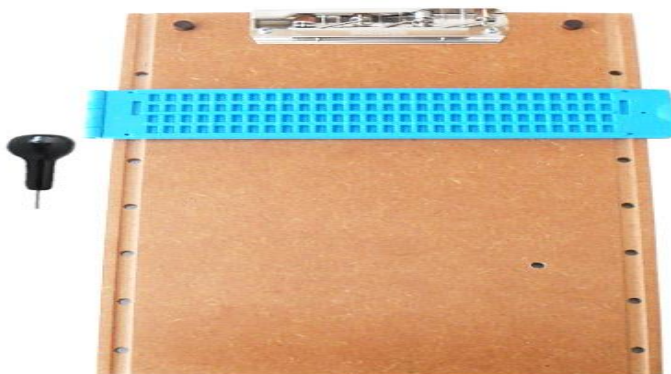
The composition of the so-called braille cell is given to a matrix, formed by six points divided into two vertical columns. On the left, from top to bottom are points 1, 2 and 3 and on the right, in the same arrangement, points 4, 5 and 6. The combinations of these six points form the 63 symbols representing the letters of the alphabet, the numbers, the accented vowels, the punctuation, the musical notes, the mathematical, chemical and computer symbols and other graphic signs. The following is the arrangement of the dots in a braille cell that is still empty:



Available in:

<https://movimentoculturalgaia.wordpress.com/2010/10/16/braille-%E2%80%94-pontinhos-de-luz/>

For the effectiveness of braille writing there are two types of support: the manual composed of a clipboard, a crimp (plastic or metal ruler composed of several leaked cells) and a puncture. And the mechanical support that is known as braille typewriter. The pictures below illustrate the statement:



Wooden clipboard, with a blue plastic crimp and a black metal-tipped punch.



<http://www.cirurgicaexpress.com.br/prod,idloja,2027,idproduto,3124021,conforto-do-paciente-reglete-de-mesa-em-plastico-com-prancheta-madeira-e-puncao-bengala-branca>



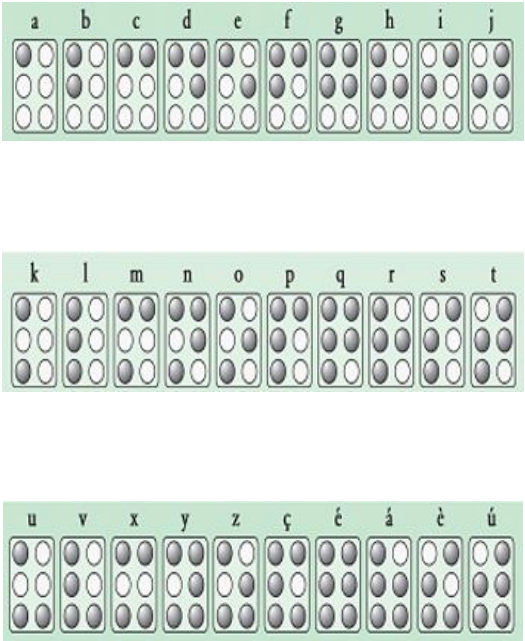
Braille laramara machine, manufactured in Brazil, composed of nine keys: a space key, a backward key, a line advance key and six keys corresponding to the points.

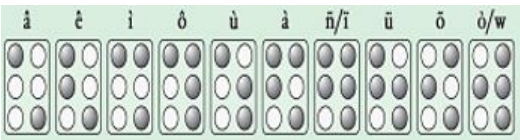
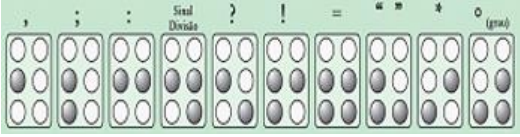
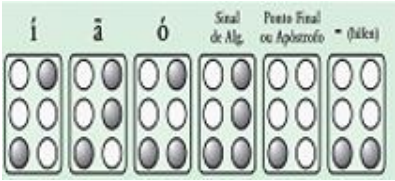
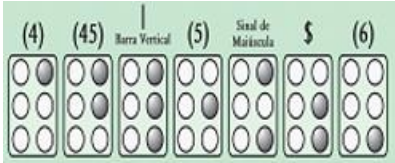
Available in: <http://www.laratec.org.br/MBrailleLM.html>

Continuing, the braille alphabet (in the reading position) is presented:

Braille Alphabet

#### Universal Layout of the 63 Simple Braille Signals

<p>1<sup>st</sup> series - upper series - uses upper points 1245</p> <p>2<sup>nd</sup> series is the result of adding point 3 to each of the 1<sup>st</sup> series signals</p> <p>3<sup>rd</sup> series is the result of adding points 3 and 6 to the 1<sup>st</sup> series signs</p>	
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4 <sup>th</sup> series is the result of adding point 6 to the 1 <sup>st</sup> series signs	
5 <sup>th</sup> grade is formulated by the 1 <sup>st</sup> grade signs positioned at the bottom of the cell	
6 <sup>th</sup> grade is formulated with the combination of points 3456	
7 <sup>th</sup> grade is formulated by signs that use the points in the right column of the cell (456)	

Available in: <https://especialdeadamantina.wordpress.com/2011/07/04/alfabeto-braille/>

As Gil (2000) points out, the main causes of visual impairment (subnormal vision and blindness) are: "[...] retinopathy of prematurity; congenital cataract; congenital glaucoma; optical atrophy; retinal degeneration and cortical visual alterations; and due to diseases such as diabetes, retinal detachment or eye trauma." The illustrations below show how people with some of the pathologies mentioned above see daily.



Normal vision and glaucoma vision.

Available in:

<http://www.hospitaldeolhosdoparana.com.br/noticia/428/dia-nacional-de-combate-ao-glaucoma-o-que-voce-sabe-sobre-esta-doenca#.Vp6BemcUX4g>



Normal vision and cataract vision.

Available in: <http://www.drbarella.com.br/catarata.html>



Normal vision and vision with diabetic retinopathy.

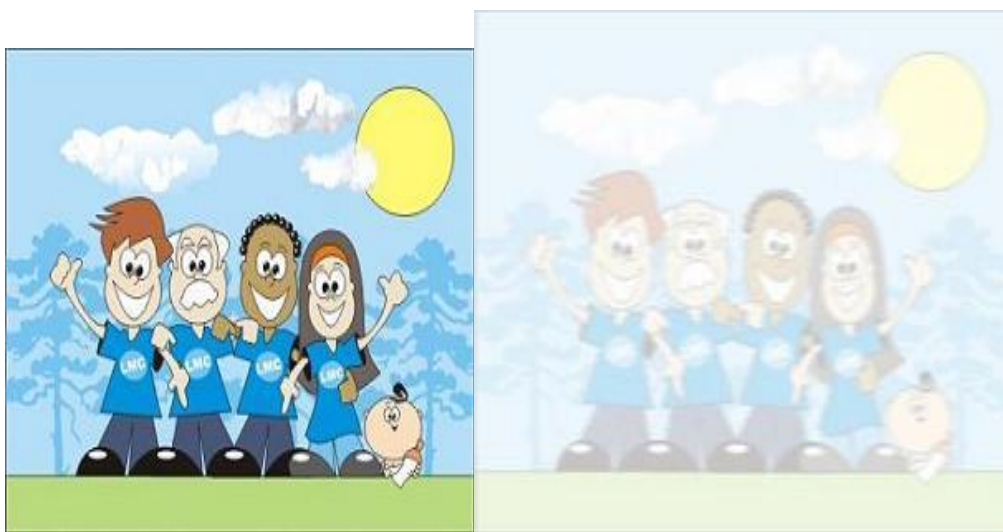
Available in: <http://manualdadiabetes.com.br/retinopatia-diabetica-o-que-e-e-como-evitar/>





Normal vision and vision with retinal degenerations.

Access at: <http://www.umani.com.br/index.php/degeneracao-macular-relacionada-a-idade-dmri/>



Normal vision and vision with retinal displacement.

Access at: <http://stargardtbrasil.blogspot.com.br/2010/05/como-enxergamos-parte-2.html>

Like all children, children with visual impairment - VI need a concrete routine with repetitions of touch, to catch, to play, to know themselves and others. For VIs, all these experiences are a different way of looking at them. The playful routine, in turn, is a fundamental ingredient for the development of all children in their first years of life.

Students with visual impairment, according to Brazil (s/d), "[...] they do not constitute a homogeneous group, with common learning characteristics, and [...] it is a mistake to consider them as a group apart, since their basic educational needs are generally the same as those of normal-vision children" (BRAZIL, s/d, p. 7).

Students with visual impairment - VI should be adequately stimulated in the improvement of their tactile discrimination, which is a primary skill for blind people, and this stimulation takes place through playful activities with the help of toy and play.

### **3. The importance of toys and playing for visually impaired children – VI**

As Gabaglia (2008, p. 1) points out, children with Visual Impairment - VI should be stimulated from an early age with regard to the exploitation of the haptic system. For this it is important to work with playful activities, exploration of toys and games, with the purpose of "[...] develop a set of tactile skills and basic concepts that have to do with the body in motion, with spatial orientation, motor coordination, direction, among other skills."

Domingues (2010) dialogues about the importance of tactile discrimination, understanding it as: Tactile discrimination is understood as "[...] a basic skill that should be developed in children with blindness in a contextualized and meaningful way. Touch is an alternative route of access and processing of information that should not be neglected in education" (DOMINGUES, 2010, p.35). As the author points out, "The haptic system is composed of cutaneous and kinesthetic receptors in which information from the medium is conducted to the brain to be interpreted and decoded. Thus, cold or heat and pain and pleasure are involuntary and consistent sensations [...]" (DOMINGUES, 2010, p.35). On the other hand, such sensations "[...] they can be regulated or controlled by artifice and outdoor conditions, while the touch in motion can be directed and oriented voluntarily to detect stimuli and information about the characteristics of an object (DOMINGUES, 2010, p.35).

The stimulus to the exploitation of the haptic system in blind children, in the playful culture, is realized through activities developed with toys and games. As Lewi-Dumont (apud JALBERT, 1997) points out, hands are essential instruments of knowledge for a blind person. For him, the child with blindness uses his/her hands, not only to pick up, throw or give objects, but also to perceive his weight, his shape and texture.

The Visually Impaired should be free to explore the objects with his hands in order to have the possibility to know the shapes, the weight, the texture of everything around him, because the hands are the main way to know the world around. This tactile stimulation should start early, so that you get a good development and tactile refinement through the handling of objects and toys that are part of your daily life. According to Vigotsky (1997, p. 112), "[...] the education of the blind child should be organized as the education of the child capable of normal development [...]"

Siaulys (2005) "[...] emphasizes the need for toy and play, as a simple and pleasant way to stimulate the integration of the remaining meanings and the constitution of a non-visual perceptual reference."

The literacy of children with Visual Impairment - VI is done with the support of teachers, trained and specialized in VI. In the turn of the class, this student should receive specialized educational care - SEC in the multifunctional resource room type II, room that provides the appropriate materials for the realization of specific care for the Visually Impaired - VI.

Type I multifunctional resource rooms are designed and embodied to receive students with various types of disabilities, except visual impairment. The type II multifunctional feature room differs by being specially planned to receive only students with visual impairment, with all the features of the type I room.

Until now, the Brazilian government has made available to schools, in the public school system,

two types of multifunctional resource rooms, according to Ropolli (2010), which are characterized as follows:

The Type I Multifunctional Feature Rooms consist of microcomputers, monitors, headphones and microphones, scanner, laser printer, keyboard and mouse, mouse and pressure trigger, laptop, accessible educational materials and games, software for alternative communication, hand magnifying glass and electronic magnifying glass, inclined plane, tables, chairs, cabinets, melanic frame.

[...]

Type II Multifunctional Resource Rooms consist of Type I room features, plus other specific resources for the care of blinded students, such as Braille printer, Braille typing machine, table crimp, punch, Soroban, signature guide, accessible globe, accessible geometric drawing kit, sound calculator, graphics and tactile production software (ROPOLLI, 2010, p. 31-32).

The appeal room provides the appropriate materials for the performance of specialized educational care and also the performance of a teacher trained to work in this place. This teacher differs from the others, because, in order to meet students with visual impairment, there is a need to know the braille system and how to properly use the other resources available in the type II resource room.

The playful in educational actions plays a fundamental role as a mediator method of child learning and, thus, contributes greatly in the promotion of the health and well-being of each child. According to Winnicott (1995), "the playful is considered pleasurable, due to its ability to absorb the individual intensely and completely, creating an enthusiasm atmosphere".

In line with the discussion made, Pinto & Tavares's argument (2010) points out that it is through play that "children channel their energies, overcome their difficulties and modify their realities, all this provides conditions for the release of fantasy and transforms it [sic] into a great source of pleasure". In other words, "[...] play is a source that helps in improving results by educators interested in promoting change" (PINTO & TAVARES, 2010, p. 226).

Every game has a purpose, and every child sees play as a new pleasurable challenge to be overcome. As Brougère (2004) states, "play is a space in which fabulous learning is allowed and, even if at times it becomes uncertain, it is an environment of relationships between children, providing the knowledge of the "self" and the other".

Over time, games and plays followed the evolutions. "But the pleasure of playing has not changed. When we look closely at children's play, two characteristics stand out immediately: the pleasure that surrounds the game is opposed to moments of tension, to a serious penetration of the players involved" (FRIEDMANN, 1996, p.11).

Toy and play are the main source of concrete material for literacy and the development of distinct skills of children with Visual Impairment - VI. It is also interesting to use scrap materials with which children with VI can prepare some toys, because, in addition to motivating them, it also helps in the development and tactile refinement.



## 4. Methodology

The methodological references that conducted this article are based on qualitative research with a bibliographic approach. Bogdan and Biklen (2003, p.49) point out "The qualitative research approach requires that the world be examined with the idea that nothing is trivial, that everything has the potential to constitute a clue that allows us to establish a more enlightening understanding of our object of study". Bibliographic research, in turn, is the basis in the construction of a scientific work and, according to Michel (2009), is characterized by the consultation of bibliographies pertinent to the article and, in this process, the researched contents are used for the analysis of the theme.

In this direction, the main theoretical contributions of this work focus on authors such as: Brougère (2004), Bruno (1997), Domingues (2010) Gabaglia (2008), Gil (2000), Honora e Frizanco (2008), Pinto and Tavares (2010), Ropoli (2010), Siaulys (2005), among others.

## 5. Conclusion

Play is a key ingredient in the meaningful learning of any child, but toy and play are essential mainly in the learning of children with Visual Impairment, it is through the toy that children with VI go groping and, thus, learning to identify how are the shapes, weight and texture of objects that are present in the routine of their daily life.

Toy and play expand the possibility of developing certain skills in children, such as: perceptual, motor, intellectual, affective and social skills. These skills acquired through play stimulate the interaction of social practices of the visually impaired.

The fundamental ingredients in the life of any child are the toy and the act of playing, and these become essential in the lives of children with Visual Impairment - VI, because, in addition to improving all their development, the toy also becomes an inexhaustible source of pleasure and, thus, contributes to the promotion of the health of these children.

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