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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-04 of IJIER*** which is scheduled to be published on **1st April 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 screensed 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,

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Table of content

Paper ID	Title	Page
2979	**Impact of the Covid 19 pandemic on preclinical teaching in medical schools-Lessons learned** ***Authors:*** *Ghassan Nabbout, Camille Nassar*	1-9
3007	**Cytogenetic evaluation of α, β-amirina obtained in resin of Protium heptaphylum (Aubl.) Marchand in polychromatics erythrocytes of mice swiss.** ***Authors:*** *Lucas Rodrigues do Rego, Everton Pantoja Vale, Danilo Dheyvison Nascimento Pureza, Moacir de Azevedo Bentes Monteiro Neto, Fernando Antônio de Medeiros, Rebecca Martins*	10-21
3013	**Education in rights and citizenship instruction: epistemic elucidation as from Paulo Freire** ***Authors:*** Ana Beatriz Albuquerque Bento, Fernando da Silva Cardoso	22-28
3016	**Machine Learning and Finance: A Review using Latent Dirichlet Allocation Technique (LDA)** ***Authors:*** *Ahmed Sameer El Khatib*	29-55
3017	**Analysis of Management in Health and Safety at Work Related to Employees Working in Health Teaching / Research Laboratories in a University** ***Authors:*** *Vilson Menegon Bristot, Cristina Keiko Yamaguchi, Kristian Madeira, Vilmar Menegon Bristot, Marcelo Leandro de Borba, Márcio Carlos Just, Leopoldo Pedro Guimarães Filho, Jacir Favretto, Suelen Brasil Giordani*	56-60
3019	**CORPORATE EDUCATION DRIVING ASPECTS TOWARDS NETWORKED CORPORATE UNIVERSITY** ***Authors:*** *Marta Silva Neves, Patrícia de Sá Freire*	61-73
3022	**Acquiring Knowledge, the Quilombola Territory of the Jambuaçu River through the Games** ***Authors:*** *Jasmine Priscyla Leite de Araújo, Ana Carolina Monteiro dos Santos de Alcântara, Fabrício José Brito Barros, Gervásio Protásio dos Santos Cavalcante, Bruno Souza Lyra Castro, Miércio Cardoso de Alcântara Neto, Arthur Tavares Nunes*	74-80
3023	**INTELLECTUAL PROPERTY IN THE PERFORMANCE OF PHYSICAL EDUCATION PROFESSIONALS CHARACTERIZING ELEMENTS FOR COPYRIGHT PROTECTION** ***Authors:*** *Tiago de Melo Ramos, Jaldemir Santana Batista Bezerra, José Ediclei Santos Silva, Flávio Valdir Kirst, Maique dos Santos Bezerra Batista, Ana Carla Barboza Canuto, Robelius De-Bortoli*	81-90
3024	**The Effects of The Tanzanian Railway Network in the Performance of the Rail Freight Operations: A Case of Dar es Salaam to Isaka** ***Authors:*** *Edwin Leonard, Lilian Macha*	91-109
3025	**Availability of raw materials in the state of Piauí for the production of ceramic coating** ***Authors:*** *Paulysendra Felipe Silva, Francisca das Chagas Oliveira, Rebeka Manuela Lobo Sousa, Phillype Dowglas Lopes, Italo Gutierry Carneiro da Conceição, Gilvan Moreira da Paz, Roberto Arruda Lima Soares*	110-119

3026	**The relationship between Investments to Increase Human Capital in the HEI and the Return on Intellectual and Integrative Capital** ***Authors:*** Jaldemir Santana Batista Bezerra, Tiago de Melo Ramos, Robelius De-Bortoli	120-128
3031	**Biosafety and action in front of COVID-19: What do we know?** ***Authors:*** Anna Clara Cachoni, Micael Borges Cadari, Augusto Alberto Foggiato, Juliana Zorzi Coléte, João Lopes Toledo Neto, Fabrício José Jassi, Douglas Fernandes da Silva	129-141
3033	**USE OF ASSOCIATION RULES TO PERFORM THE MINING OF A MARKETING DATABASE COMERCIAL** ***Authors:*** *Priscilla Leão de Lima, Richardyson Nobrega da Fonseca, Rilmar Pereira Gomes, David Barbosa de Alencar*	142-152
3035	**EVALUATION OF ACCESS TO ORAL HEALTH AND THE NEED FOR TREATMENT IN ADOLESCENTS IN A FULL-TIME SCHOOL SYSTEM** ***Authors:*** *Priscilla Bittencourt de Almeida Figuereido, Suelly Maria Mendes Ribeiro, Marina Glaucia Alves Ramos, Miriam Almeida Alho, Arilson Lobo Figueiredo*	153-163
3038	**Comparative analysis of sustainability assessment methods in agroecosystems** ***Authors:*** *Ana Paula Silva de Santana, Alceu Pedrotti, Fernanda Cristina Caparelli de Oliveira , Francisco Sandro Rodrigues Holanda, Claudinei Martins Guimarães, Ana Paula Schervinski Villwock, Arisvaldo Vieira Mello Jr., Raimundo Rodrigues Gomes Filho, Renisson Neponuceno de Araújo Filho, Sara Julliane Ribeiro Assunção*	164-182
3039	**Teachers' Physical Activity: A Necessity for Stability of Schools' Culture During the COVID-19 Pandemic** ***Authors:*** *Gerby Parra, Emily Tan*	183-191
3040	**OZONIZED AND NATURAL COMPOUNDS FOR IN VITRO ACINETOBACTER BAUMANNII TREATMENT** ***Authors:*** *Wagner Rafael Da Silva, Dora Inês Kozusny-Andreani, Rogério Rodrigo Ramos*	192-208
3041	**EFFECTIVENESS OF DEVELOPED WORKSHEETS TO THE ACADEMIC ACHIEVEMENT OF STUDENTS IN SCIENCE 9 CONCEPTS** ***Authors:*** *John Manuel Cotares Buniel, Vilma Agua Monding*	210-214
3042	**A Changes In Hormonal Response Caused By Different Types Of Physical Exercise A Literature Review** ***Authors:*** *Flávio Henrique Souza de Araújo, Raquel Borges de Barros Primo, Mi Ye Marcaida Olimpio, Nathalia Oliveira da Silva, Catherine Alexia Yoshikawa, Lígia Harumi Vilela Bartnick Tanaka, Vinício Guimarães Freitas, Luiz Fernando Benazet de Assunção Pereira, Thais Gimenes Bachega, Silvia Aparecida Oesterreich*	215-222
3043	**The roles of student engagement motivations in learning and managing.** ***Authors:*** *Ngo Hai Quynh, Nguyen Thanh Hoai, Nguyenthingoc Thu*	223-234
3044	**COOPERATIVE COMMUNITY OF NETWORK LEARNING experiences of remote teaching in the Technical course of Administration, integrated into High School, from the Instituto Federal de Educação, Ciência e Tecnologia Baiano.** ***Authors:*** *Aline Fonseca Gomes, Carolina Costa Silva, Cleidida Barros de Carvalho, Gabriela Nascimento Prates, Giovana Miranda Pedrecal Meirelles, Ivanildo Rocha Porto, Joselito da Silva Bispo, Vagner Costa Oliveira*	235-248

3045	**Effect of Students' Attendance on their Academic Performance in Some Engineering Courses at the United Arab Emirates** ***Authors:*** *Abdel Hamid Ismail Mourad, Mohamed YE Selim , Shafaa Al–Maqdi, Ghadi Abueleyan, Aya Mansour, Moudi Alamer, Maryam Alantali*	**249-262**
3050	**Corona Virus Pandemic and Social Isolation Process Influences on Increased Violence Against Women: an integrative review** ***Authors:*** *Débora Batista de Souza Rocha, Andrea Mara Bernardes da Silva, Ana Carolina Silva Gonçalves, Vivian de Moraes Coelho, Luana Araujo Macedo Scalia*	**263-287**
3054	**Innovation and organizational performance as antecedents of competitive advantage in the context of beef cattle** ***Authors:*** *MARIA EMILIA CAMARGO, José Edson Azevedo da Silva, Angela Isabel dos Santos Dullius, Beatriz Lucia Salvador Bizotto, Marta Elisete Ventura da Motta, Janine Bertelli*	**288-303**
3058	**Language teacher professional education: The role of peer-to-peer learning in online environments** ***Authors:*** *Kátia Muck, Denise Cristina Kluge*	**304-317**
3059	**THE APPLICATION OF DATA MINING BY CLASSIFICATION IN A DATABASE OF NOTIFIED COVID-19 CASES IN MANAUS-AM** ***Authors:*** *Fábio Gomes Cantuário, Luiz Eduardo Santos de Araújo, Rilmar Pereira Gomes, David Barbosa de Alencar*	**318-330**
3060	**The Agronomic performance and physicochemical characteristics of onion genotypes under different spacing in the humid Amazonian tropics** ***Authors:*** *Luiz Carlos Piacentini, Bruna Corrêa Moreira, Cláudia Barbosa Cordeiro, Augusto Uchoa de Andrade, Marcos Ribeiro da Silva Vieira, Miguel Alves Júnior*	**331-349**
3061	**Effects of Multiple representations and Problem- solving learning strategies on Physics students' problem-solving abilities** ***Authors:*** *YINKA TOSIN ORULEBAJA, OLATUNDE LAWAL OWOLABI, HAKEEM AKINTOYE*	**350-365**

Impact of the Covid 19 pandemic on preclinical teaching in medical schools-Lessons learned

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Abstract

***Objectives**: The authors analyzed the weaknesses and areas of opportunities with the online teaching imposed by the COVID19 lockdown, and the new measures adopted to control the online examinations for medical students.*

***Method:** In addition to personalized question sets we had location mapping and Open Broadcaster Software (OBS) for monitoring students during the exams as well as disabling the back-button during examination.*

***Results:** The academic year was successfully completed on time. There was no change in the exams format or scope, yet the results were similar in terms of grade distribution, average and standard deviation as well as the validity and reliability scores.*

The students' perception of online teaching was evaluated through a survey. It revealed the importance and added value of online teaching but also exposed the gaps related to lecturers' preparedness and need for training.

***Conclusion:** The online experience was a valuable lesson for us, as we discovered not only the weaknesses or areas to improve, but also new ways and opportunities that can be explored to enhance the learning experience.*

Our plan is to introduce online teaching gradually to all modules and align it with students' readiness through direct implications of students; however, every center should develop its own long-term plan to address its own problems and weaknesses.

Keywords: Online medical education**,** Medical education during lockdown, Impact of COVID19 on education.

Introduction

The imposition of the social lockdown due to Covid 19 pandemic produced new challenges concerning the education in medical schools, not only for lectures delivery but also for online exams and assessment of students.

The Faculty of Medicine (FOM), at the University of Balamand, maybe the first faculty in Lebanon, and certainly one of the few worldwide, to go completely online with no delays in the schedule for the basic sciences years, and was able to finish the academic year on time, with no compromise on the content or quality of the curriculum.

The FOM adopts the American system of medical education where students are accepted after three years of undergraduate studies and earning a BS degree. The medical program consists of two years of basic sciences and 2 years of clinical clerkship. Our study covers the two basic years. We have started the horizontal integration system five years ago, with system-based integrated modules for the first and second medical years, the preclinical years, with a vision for a more holistic horizontal integration of both years into one bulk of preclinical medical studies.

Normally, we use the MOODLE platform (Modular Object-Oriented Dynamic Learning Environment) to post grades, notifications, syllabi and lectures handouts for the students and on some occasions for computer-based exams done in FOM's computer lab with direct supervision and monitoring. We upgraded our use for MOODLE to online exams.

Having finished the curriculum on time, and looking back at this experience, we can say that it was a valuable lesson for us, as we discovered not only the weaknesses or areas to improve, but also new ways and opportunities, that can be explored to enhance the learning experience. We hope, once the lockdown is lifted, to use these modalities alongside the classic classroom teaching.

Areas affected by the lockdown

The problems faced were due to the lack of physical presence of both students and staff, and the decision to go completely online.

1- Lectures: Of course all lectures had to go online and from the beginning all lectures were started the lectures on WebEx where students could attend and interact. Only few lecturers opted for posting recorded lectures, however, a Q&A or review session was added in that case.

   One of the major challenges encountered is that the internet is not always reliable and we have multiple power failures, thus affecting online teaching and exams. Other specific challenges were also encountered:

- Several students and lecturers didn't have a compatible PC they can use to connect to the lectures or exam, so a laptop was ensured by the university for those students.

- Several students didn't have good internet connection all the time and so all lectures were recorded and posted.

2- Exams: The challenge with the exams was to monitor the students and control and prevent students' communication. As we follow a modular system, the exams were the final exams and sometimes the only exams for each module. Exams are usually between 80 and 100 MCQ questions with 1 minute per question. The decision to have exams online was understandably met with considerable resistance from the students who raised concerns as to the ability to control and prevent cheating and the reliability of the internet; however, with proper explanation and briefing about the methodology, it was widely accepted.

Assessment methodology

Exams: The online exams for medical students are previously reported by some colleges (Tapper, Batty and Savage, 2020) and the measures described to prevent communication are based mainly on the time limitation and shuffling of the questions.

To ensure the integrity of the exams different control modalities were taken:

a. Location mapping: this was done to ensure that students are distant geographically from each other so direct communication was impossible.
b. Online streaming with screen monitoring and recording: All students had to use the Open Broadcaster Software (OBS) for streaming and were watched over monitors. All exams were also recorded for future reference.
c. Personalized version: all questions and answers were shuffled.
d. Back button disabled: This means one can't review his answers and this is certainly a limitation for the students but a necessary measure to control student's communication.
e. One question per screen.
f. Each exam into sections of 20 questions each, in case of a major system failure.

Lectures:

All lecturers were contacted and all had a WebEx account created for them and online training and support. All lectures were recorded and posted on MOODLE for review and for students who had internet problems. Lecturers who wanted to post a recorded lecture were also supported online.

Lab sessions:

Since the dissection laboratory couldn't be accessed, we had to resort to virtual dissection which is a valuable alternative, though not as real as the hands-on dissection.

Results

The results comprise the students' evaluation of lectures, lecturers and exams. The validity and reliability of exams are also reported.

Lectures and lecturers

A survey to evaluate the students' perception of online teaching, material and lecturers was carried out among the med1 and med 2 students. Out of a total of 183 students, 99 med 1 and 84 med 2, 151 students completed the survey (95 med 1 or 96% and 56 med 2 or 67%).

The comparison of online to classroom lectures is summarized in [table 1].

Table 1 comparison between online lectures and classroom lectures in terms of converying information

	Yes	No	Depends on the lecturer	Depends on the content
Recorded lectures convey the information properly despite the fact that they lack the physical presence of the lecturer	15.2%	16.6%	44.4%	23.8%
The WebEx lectures were similar to class lectures in terms of interaction and explanation	12.6%	33.1%	54.3%	

The lecturer was the most important factor in the success of online lectures, although for recorded lectures the content was also a significant factor. One can assume that for certain basic, informative lectures where a lot of information is given and the student may need to go over and over the material several times, less interaction may be required that clinically oriented lectures.

The feedback about the lecturer's mastering of the online delivery methodology and techniques are summarized in [table 2].

Table 2 feedback about the lecturer's mastering of delivering lectures online.

	Yes	No	Not sure
The recorded lectures are more affected than the class lectures by the lecturer's mastering of the language and tonality.	62.9%	12.6%	24.5%
Training the lecturers to record lectures would improve the quality of the recorded lectures.	90.7%	2%	7.3%
Training the lecturers for online interactive lectures would improve the quality of these lectures.	88.7%	3.3%	7.9%

About 90% of all students agree that training the lecturer would improve the quality of the lectures. This involves the duration of recorded lectures and the number of slides as well as the ability to use easily the online platform including screen and multimedia sharing.

Exams

We had three online final exams for med 2, for 3 modules out of a total of 13 modules, accounting for 11 credits out of the total of 43 credits; for the Med 1 students, we had 6 exams for 6 modules out of 13 modules, accounting for 23 out of the total 43 credits. There was no change in the exams as far as number of questions or difficulty and material covered as compared to previous years, yet the results were similar in terms of grade distribution, average and standard deviation as well as the validity and reliability scores [table 3].

Table 3 Comparison of validity and reliability score between this year's online exams and last year's in-house exams.

		Med 1 (99 students)		Med 2 (84 students)	
		Online	Last year's in house exam	Online	Last year's in house exam
Exam1	*Combach's alpha Reliability Coef*	0.92	0.85	0.92	0.65
	S-CVI/Average Validity Coef	0.63	0.65	0.74	0.65
Exam2	*Combach's alpha Reliability Coef*	0.84	0.91	0.85	0.66
	S-CVI/Average Validity Coef	0.73	0.65	0.71	0.57
Exam3	*Combach's alpha Reliability Coef*	0.88	0.49	0.92	0.96
	S-CVI/Average Validity Coef	0.73	0.63	0.76	0.63
Exam4	*Combach's alpha Reliability Coef*	0.82	0.91		
	S-CVI/Average Validity Coef	0.71	0.66		
Exam5	*Combach's alpha Reliability Coef*	0.80	0.9		
	S-CVI/Average Validity Coef	0.71	0.57		

Also, comparison of students' performance prior to the lockdown and after it was made in terms of grades and ranking.

For the Med 2 students, the top 20% remained unchanged with the same order for the top 5 %. For the Med 1 students, the top 10% remained unchanged with a switch in order between the second and third places, with 2 new students who made it into the top 20%.

Discussion

A careful analysis of what was achieved, enticed a review all the procedures and look into gaps in infrastructure and preparedness, and how to make use of this experience to enhance the teaching and learning experience.

We live in a country where internet is not reliable and we have multiple power failures and this certainly can jeopardize online teaching and assessment. In addition, other problems were also encountered and had to be dealt with immediately.

The problems described so far could have been avoidable and can be divided into technical and human but also into preparedness and readiness as depicted in the [table4] below:

Table 4 Problems encountered in online teaching and exams.

	Technical	Logistics
Preparedness	• Not having the required platform updated and debugged. • Not having a unified format for all lectures delivered by doctors	• Not all doctors and students have a compatible PC and internet to get connected.
Readiness	• Not all doctors are oriented how to connect to the university platform for online lectures or to upload.	• Not being accustomed to online exams and lectures. • Resistance to change

Although virtual classrooms have been around for sometime now, they were not used globally for education as it happened during the pandemic. Opponents and proponents alike were forced into virtualization whether they were prepared or not.

The problems we faced were not peculiar to our faculty but are well known and clearly identified in the literature and include time constraints in an overcrowded schedule, poor technical skills or preparedness to use the virtual classrooms, and inadequate or unreliable infrastructure (Bediang et al., 2013; O'Doherty et al., 2018). In addition, one should expect the resistance to any new modality and the expected fear to change (Petterson and Olofson, 2015). On the other hand, the students mix and background is a critical factor in determining the success of any strategy that one would adopt to enhance distance learning. Cognitive and emotional maturity of the students should be taken into consideration when deploying a system that engages

the students and it is the student's learning readiness that we need to improve while introducing online lectures and exams (Bhagat et al., 2016). In our quest to make our students active independent learners, we have found in the experience we got from online teaching, an opportunity to help achieving this goal. The online teaching is not an end by itself and we intend to implement it in as much as it promotes the active learning, improves the quality of the teaching, and helps us achieving our vision in developing a horizontal integration throughout the basic sciences years. This is why it should be complemented with adequate student's feedback.

Lectures:

The online lectures may not always be a blank substitute for classroom lectures especially when it comes to students' engagement and motivation that can be enhanced by the physical presence and appropriate body language (Zeki, 2009), in addition to the difference in cognitive maturity of students within the same faculty that makes the physical presence within a classroom more important (Cigdem and Ozturk, 2016), but they can have added values that shouldn't be abandoned once the lockdown is lifted (Brecht, 2012):

- Help the students to get the most out of in-class sessions as they prepare or go over the recorded lectures.
- Provide the possibility of reviewing the material at any time.
- Encourages the student to be self-dependent
- Alleviates the crowded schedule giving more time for interactive and group discussion sessions.
- Interactive live online lecture can be used for oversees lecturers or to join a keynote lecture given by a prominent specialist anywhere in the world.

Reengineering of the modules to become knowledge oriented rather than topic oriented this prevent the duplication and redundancy of some information, which might be inherent in an integrated system (Royal, Gillilan and Dent, 2014; Mayer and Johnson, 2014).

Exams

The online exams can certainly offer much more than paper-based exams. One can incorporate dynamic media such as CT or MRI and not mere pictures and even whole electronic medical records. This would help changing the testing methodology to more of combination of formative and summative types, combining the MCQ questions to case-based open type questions that can be added as open book take home exams (Walsh, 2015). This would certainly help the student to assimilate the information gathered into problem solving knowledge, and can help the smooth transition into a vertical integration where clinical cases are gradually introduced into the basic sciences curriculum.

Time management

Going online, even partially and gradually, and adhering to an online schedule and calendar, and allowing the students to choose when to study a lecture may improve the time management skills of the students especially in a crowded schedule where some students are unable to find their pace, or unable to keep up with the material. (Schimming, 2008)

Technical issues

This is mainly related to the gaps that were identified and mentioned above. It is not enough to have fixed them on time and for the time of lockdown; rather, they should be centralized and continuously monitored through the creation of an educational IT team or the faculty that should oversee the utilization and maintenance of all technical platforms.

We have prepared a list of minimum and maximum requirements that need to be present on every student and lecturer laptop, such as OBS, Moodle, media for medical imaging etc. All laptops would be required to have passed an IT check at the beginning of next year.

For the coming year our plan includes:

1- Creating an educational IT team: the aim of this team is to ensure that all laptops and tablets for all the staff and students are well up to date and all necessary software are downloaded with training of the staff and students how to use the required platform and manage frequent dysfunctions, in addition to a help desk.
2- In addition to the in-class lectures, in case the lockdown is not imposed, we plan to have up to 10% online lectures
3- Training sessions for the staff on order to improve the presentation of recorded lectures including the number of slides and lecture format.
4- Training sessions for better interactions during the WebEx lectures and hands-on for the utilization of multimedia and animation during the WebEx lectures.

Conclusion

With the lockdown imposed, the online teaching was imposed on all, but for some, this experience was a fear breaker. We should build on what was achieved in the field of online teaching and explore its potentials. We have learned that:

1- Students believe that online teaching has an important added value to complement class teaching.
2- Students' familiarity with online interaction is a major factor in adapting to online teaching.
3- Lecturers need to be trained to use online platform and to adapt the lectures to online teaching.

Our plan is to introduce online teaching gradually to all modules and align it with students' readiness through direct implications of students. Every center should develop its own long-term plan to address its own problems and weaknesses.

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Cytogenetic evaluation of α, β-amirina obtained in resin of *Protium heptaphylum* (Aubl.) Marchand in polychromatics erythrocytes of mice swiss.

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Abstract

The Amazon Rainforest has a great variety of medicinal plants, among them we can highlight the "Almecegueira" or "Breu Branco" (Protium heptaphylum) in Portuguese, the producer of a greenish-white resin that hardens when it touches the air, known by its gastroprotective and anti-inflammatory effects. These effects are attributed to a triterpene mixture of α and β amirine, predominant in the resin. The purpose of the study is to obtain a cytogenetic profile to the α, β-amirine mixture obtained in the resin of P. heptaphylum. For this, the micronucleus test was used in peripheral blood and bone marrow; administering solution in Swiss mice with the dosages of 1mg/Kg, 3mg/Kg, and 10mg/Kg, diluted in 5% DMSO, the effects were observed in 24h and 48h after the treatment. For the test in peripheral blood the mice's caudal vein was punctured, while for the bone marrow test, the femurs of the animals were obtained from which bone marrow samples were taken. It was found that in peripheral blood, the administration of the compounds did not cause genotoxicity in 24h and 48h, in contrast, antigenotoxicity was, for concentrations 1; 3 and 10mg/kg, respectively 10%; 12%; 67% in 24h and 9%; 15%; 73% in 48h. In the bone marrow, no genotoxicity was observed, as for antigenotoxicity was observed that for

concentrations 1; 3 e 10mg/kg the percentage of reduction was respectively: 11%, 15%, and 30% in 24h and 13% 16% 33% in 48h. It is concluded that the studied compound can be an alternative for treatments in the future since it presents low toxicity and high antigenotoxic potential.

Keywords: Almecegueira; α, β-amirine; Amazon Rainforest.

1. Introduction

Since the beginning of man's history, nature has been a source of a search for health problems. The use of plants to treat and prevent diseases has already been used for thousands of years. Studies carried out, along with the remains of the first hominids, could prove the use of medicinal plants for the most diverse purposes for about 60 thousand years ago (Karam, 2013). Plants are capable of producing a large quantity amount of bioactive molecules resulting from their metabolism and most plants naturally produce a great variety of bioactive molecules, called secondary metabolites, which can be obtained from different parts of the plants (Punjab et al., 2012). A wide range of biological activities is described for these of secondary metabolites, such as, for example, antitumor, anti-inflammatory, antioxidant, antibacterial, antiparasitic, antiviral, among others (Oliveira et al., 2011). The Amazon Rainforest owns a wide variety of medicinal plants, among which we can highlight the "Almacegueira" or "Breu Branco" (*Protium heptaphylum)* in Portuguese, producer of a greenish-white resin that hardens in contact with air, popularly used for its gastroprotective and anti-inflammatory effects (Araujo et al., 2011; Zappi,, 2015; Brasil, 2018). In the literature, there are some secondary metabolites obtained through *Protium. Heptaphylum* resin, among them a considerable part is a triterpene mixture of α e β amirine from which a series of derivatives such as formate, acetate, benzoate, and cinnamate can be obtained (Bandeira et al., 2001; Bandeira et al., 2007).

The arimines are pentacyclic triterpenes that can be divided into ursane, olean, and lupeol, and present basic differences in chemical structure, only in the aromatic ring "E", so then, when the ring is positioned ate C20 and contains two methyls it's called β – amirine, in contrast when the methyl radical is linked to C19 it's called α – amirine (Bandeira et. al.,2007; Florentino, 2018). The triterpenes eeing present as major constituents of resin produced by a large number of plant species, among which are the species of the genus Protium (Dias, Hamerski and Pinto, 2011). They perform important functions such as defense (phytoalexins), insect repellent, agents of pollen attraction, defense agents against herbivores, pheromones, allelochemicals, plant hormones, and because they function as signaling molecules (Bruneton, 1993; Mccaskill and Croteau, 1997; Verpoorte, 2000). Its use is widespread, mainly in folk medicine as healing, expectorant, anticâncer, antiviral, antibacterial, antifungal, antidiuretic, giardiacide, and acetylcholinesterase enzyme inhibitor (Bandeira, 2007), anti inflammatory activity, antiarthritic and analgesic (Dias, Hamerski and Pinto, 2011). Aragão et al., (2002) showed that the mixture of α.- and β.-Amirine has an antinociceptive effect and anti-inflammatory activity using 50mg/kg b.w.

Toxicological genetics, according to Ribeiro (2003), evaluates potential genotoxic effects, which are considered important to cancer development. Nucleic acids are often exposed to various genotoxic substances both from endogenous and exogenous sources, such as ultraviolet radiation, and substances that the individual makes use of or come in contact with (Neto, 2011; Ermolaeva and Schumacher, 2014). For

this type of experiment, there are techniques such as the micronucleus test. Through this test, it is possible to evaluate the measure of chromosomal damage and segregation errors. The micronucleus result from the production of acentric fragments or chromosomes that are delayed in their migration to the poles of the cell in anaphase. Any cell can be used for testing as long as it has undergone at least one division but bone marrow cells and blood cells are often used although effective tests using cells from other organs such as liver and embryos, embryos pre-implanted, and ovarian tumor cells (Countryman, 1976).

The micronucleus test in peripheral blood is a good option among the micronucleus testing objects, as a single drop of blood produces a large number of available cells for testing, without the need for any special processing or a trained cytogeneticist for analysis. Studies prove greater effectiveness of the Giemsa staining method for environmental studies, besides being a more reliable and practical method to be done. The bone marrow micronucleus test has more complex procedures, but it may provide even greater reliability, since the number of polychromatic erythrocytes is much higher in bone marrow samples than in peripheral blood, making it possible to analyze a considerable number of young cells in a shorter period compared to the blood smearing analysis methodology, therefore it presents itself as a more reliable methodology then the test on peripheral blood erythrocytes (Majone et al., 1988; Silva and Nepomuceno, 2010).

In this context this study aims to elucidate the knowledge towards α, β-amirine, and, since it has wide use and taking into account that the dosages considered safe for consumption are not established in the literature, in addition to their activity is not fully explained, thus constituting a potential risk for indiscriminate use. Accordingly, this study evaluated the genotoxic, antigenotoxic and cytotoxicity effects of the extract of the mixture α, β-amirine obtained from *P. heptaphylum* extract in vivo.

2. Material and methods

2.1. Materials

Doxorubicin (CAS. No: 23214-92-8) (DXR) from Rubidox® (Life Comercio de Medicamentos e Manipulação LTDA EPP, Santo Andre, SP – Lote: 1084504). All the other reagents were pure grade and used according to the manufactures´ instructions.

1.2. Vegetable material collection

The collection of plant material (resin) happened at a preservation área in octuber 2016 at Sítio São Benedito, located at Manoel Francisco de Souza street, number 414, in the São Lázaro neighborhood, coord: Lat. 00º4’ 626052” W, located in Macapá, Amapá, Brazil. A crude hexanic extract was produced from this resin. The identification of mentioned plant to obtain a resin sample and making of desiccate, registered at Herbarium Amapaense (HAMAB), of Institute of Studies and Research of Amapa State (IEPA) under the registration number 019059.

1.3. Purification of the hexanic resin extract

After obtaining the resin, a collum chromatography of 50g of 0,063-0,2mm silica gel was performed, assembled in hexane, using 1,5 g of hexanic extract from Resina do Breu. The solvent system

used started with 100% hexane, followed by: 1000ml of hexane + Dichloromethane 7:3; 500 ml of hexane + dichloromethane 4:6; 250 ml dichloromethane 1:1; 200 ml of dichloromethane + methanol 9:1; 200 ml of dichloromethane + methanol 8:2; 200 ml of dichloromethane + methanol 6:4; 200 ml dichloromethane + methanol 5:5. Altogether 108 fractions of this system were collected, which were gathered, observing their chemical similarities and evidenced in a chromatographic plate revealed in iodine particles. After gathering the fractions, a DMSO 5% solution containing α, β amirine was produced.

1.4. Chromatographic analysis

To confirm the sample used, gas chromatography analysis coupled with mass spectrometry was performed. It was made on Agilent equipment, coupled to an Agilent mass spectrometry analyzer. A 5% phenylmethyl polysiloxane column, 40 m x 0,30 mm x 0,10 µm, with flow division 15:1 and transfer at 290 °C, was used with Helium gas. Initially, the temperature of the chromatographic chamber was 110°C for 5 min, increasing the temperature by 15 °C/min up to 290 °C and then, increasing by 2 °C/min up to 300 °C, stabilizing this condition for 15 min.

1.5. Positive control (DNA damage induction)

The chemotherapeutic DXR (Rubidox® Smartfarma Ltda., São Paulo, SP) was used as DNA damage inducer in peripheral blood cells (positive control) (De Azevedo Bentes Monteiro Neto et al., 2011; Alves et al., 2013). The drug was dissolved in distilled water and administered intraperitoneally (i.p.) (0.3 mL / animal). The concentration of DXR (15 mg/kg body weight - b.w.) was set according to previous studies (Franke et al., 2005; Venkatesh et al., 2007; Vale et al., 2020).

1.6. Animals

Fifty male healthy Swiss mice (6 - 7 weeks and approximately 25 ± 5 g b.w.) were obtained from the Multidisciplinary Biotherm Center for Biological Research at Animal Laboratory Science Area (CEMIB) of the State University of Campinas (UNICAMP), Campinas - SP, Brazil. Each experimental group consisted of five animals. The experimental protocols used in this study were in accordance to the legislation for animal experimentation established by the Brazilian National Council of Animal Experimentation (CONCEA). All experimental protocols were reviewed and approved by the Animal Use Ethics Committee (CEUA) of the Federal University of Amapa (UNIFAP) under the protocol number 010/2019

2.7. Micronucleus test peripheral blood

The genotoxic, antigenotoxic and cytotoxic effects of α, β-amirine were evaluated using the micronucleus test in polychromatic erythrocytes of Swiss mice. The used concentrations of α, β-amirine, were 10, 3, e 1 mg / kg b.w., according to the literature, was administered orally by gavage (0.5 mL), to observe the processes in 24h and 48h, according to the method described by Macgregor et al. (1980). For the antigenotoxic evaluation, immediately after the extract administration, the animals were treated with an intraperitoneal injection (i.p.) of DXR (0,3 ml/15 g b.w.) and subsequently performed the analysis in 24h and 48h. The Positive Control group was DXR via intraperitoneal, the Negative Control group was

treated by gavage only with water, the Dimethylsulfoxide (DMSO) group was treated by gavage (0,5 ml/25g b.w.), and the DMSO + DXR group was treated with DMSO by gavage followed by intraperitoneal injection of DXR as previously explained (Matos et al. 2013).

Each animal´s tail tip was cut and a drop of blood was dripped and then dragged over microscopy clean blades and dried at room temperature. Subsequently, they were fixed in absolut methyl alcohol for 5 minutes and again dried at room temperature. After 24 h, the blades were stained with diluted Giemsa dye (Ministry of Health, 2009) for 20 minutes. The blades were then washed to remove the excess of dye, dried at room temperature and examined in an optical microscope (Opton TIM-2008) on the immersion objective (100x).

2.8. Micronucleus test bone marrow

Bone marrow MN preparations were made using Sehmid (1976) modified method. Where 5% bovine serum albumin (BSA) was prepared in phosphate buffered saline (PBS; pH-7.2), it was used as a suspension medium. The bone marrow suspension was centrifuged at 1000 rpm and the pellet was resuspended. A drop of suspension was spread on clean, air-dried slides. The dried slides were fixed in methanol and stained with buffered May-Grunwald-Giemsa (pH 6.8).

Micronucleated polychromatic erythrocytes (PCEMNs) in bone marrow and peripheral blood samples were calculated from 2000 cells and the nuclear division index (NDI) was determined as the ratio of polycyclic erythrocytes (PCE) to normochromatic erythrocytes (NCE) (PCE/NCE) based on 400 erythrocytes per slide (Mersch-Sundermann et al., 2004). The reduction in the frequency of PCEMNs was calculated according to the following formula (Waters et al., 1990): % Reduction = (A-B) / (A-C) x 100.

Where A corresponds to the damages from the treatment with DXR (positive control), B is the group treated with PGFP plus DXR, and C is the negative control group.

2.8. Statistical analysis

The data were analyzed statistically, by another researcher who did not participate in the other stages of this study, using the variance test (ANOVA) for entirely random experiments, with the calculation of the F statistic and its respective “p-value”. In cases where $p< 0.05$, treatment averages were compared using the Tukey method, with the calculation of the minimum significant difference for $\alpha = 0.05$. The program used will be GraphPad Prism 8.

3. Results and discussion

3.1 Chromatographic analysis

The chromatographic gas layer analysis was performed according to the protocols of Rodrigues (2010). The results found for the samples obtained in the chromatography column previously performed were similar to the results observed in the literature, confirming the presence of the compound analyzed as α, β - amirine.

3.2 Nuclear Division Index - Cytotoxicity

The cytotoxicity of treatments was measured using the IDN. The data showed the absence of cytotoxicity of the treatments in all concentrations evaluated, however, it is noted that there is a significant difference between the treatment groups and the positive control, the latter where a greater occurrence of PCE was noted than in the others; leading to the belief that the administration of DXR produced cytotoxic effects to the cells, possibly sensitizing the mass production of new cells that are still launched into peripheral blood, which would explain the significant increase in the occurrence of PCE in the CP group. Also, the behavior of the control groups with DMSO solvent was observed, in these there was no significant difference concerning the groups treated with α, β - amirine, which shows that the use of the solvent did not cause an increase in the IDN in the animals, a fact which occurred similarly in the treatment groups where there was no correlation between the treatment and the IDN, as shown in Table 1 and 2.

3.3 Genotoxicity

Initially, it was observed that the treatments performed, in all dosages of α, β - amirine used (10 mg / kg; 3 mg / kg; 1 mg / kg) did not produce genotoxic effects in both the 24h and 48h analysis in Bone Marrow and Pheripheral blood, when comparing the Control groups control and treatment it's evident that there was no correlation between treatments and the increase in the frequency of micronuclei ($p > 0.05$), as shown in Table 1. The found results corroborate with the literature, studies have shown that the use of α, β - amirine does not confer genotoxicity. In the literature, treatments with higher concentrations are found, for example, 50 mg per kg p.c. of α, β - amirine that also did not produce genotoxicity in subacute assays. (Venkatesh et al., 2007; Aparecida et al., 2006).

Regarding the analysis of the frequency of micronuclei in bone marrow, there was no significant increase ($p > 0.05$) in the frequency of micronuclei correlated to the administration of any administered concentration, as shown in Table 1. The same can be said of the IDN, both in peripheral blood and in bone marrow, the treatment groups were statistically similar to the control groups where there were no changes, except for the Positive Control group which, due to the administration of DXR, had an increased frequency of micronuclei and IDN. The data obtained are following the observations in the literature where there is no evidence of the toxicity of the compound administered (Aparecida et al, 2006).

Table 1 – Nuclear division index and absolute and relative frequency of micronuclei found in peripheral blood and bone marrow, 24h and 48h after Genotoxic treatment with α, β - amirine, by each group. 10,000 cells were analyzed for each group.

Treatment	Pheripheral Blood			Bone Marrow		
	IDN	MNEPCs		IDN	MNEPCs	
	Mean and deviation	Nº	%	Mean and deviation	Nº	%
CN 24h	0.060 ± 0.0071	14	0.14	0.060 ± 0.0071	13	0.13
DXR 24h	0.1 ± 0.0045	78	0,78	0.11 ± 0.0045	150	1.5
DMSO 24h	0.061 ± 0.0071	16	0.16	0.061 ± 0.0071	15	0.15
1mg/kg b.w. 24h	0.056 ± 0.0055	12	0.12	0.056 ± 0.0055	15	0.15
3mg/kg b.w. 24h	0.056 ± 0.0089	13	0.13	0.056 ± 0.0089	14	0.14

10mg/kg b.w. 24h	0.058 ± 0.0084	15	0.15	0.058 ± 0.0084	17	0.17
CN 48h	0.056 ± 0.0054	14	0.14	0.056 ± 0.0054	12	0.12
DXR 48h	0.10 ± 0.0044	78	0,78	0.10 ± 0.0044	163	1.63
DMSO 48h	0.062 ± 0.0045	14	0.14	0.062 ± 0.0045	15	0.15
1mg/kg b.w. 48h	0.064 ± 0.0055	12	0.12	0.064 ± 0.0055	12	0.12
3mg/kg b.w. 48h	0.068 ± 0.0045	13	0.13	0.068 ± 0.0045	13	0.13
10mg/kg b.w. 48h	0.062 ± 0.0045	15	0.15	0.062 ± 0.0045	13	0.13

3.4 Antigenotoxicity

In the second step, analyzes of the antigenotoxicity of the treatment for the 24 hours since the administration of DXR were performed, where it was shown that there is a correlation between the frequency of micronuclei and the treatments ($p < 0.05$) as shown in the Table 2. Comparing the results of the highest concentration (10 mg / kg) and the results of the micronucleus frequency of the Positive Control (DXR) and DMSO + DXR groups, there was a significant difference between them, where the group treated before the application of DXR with 10 mg / kg provided a reduction in genotoxicity in 67% in 24h, followed by the groups 3 mg / kg and 1 mg / kg, which obtained 12% and 10% reduction, respectively. In 48h, a reduction was observed for concentrations of 10, 3, and 1 mg / kg of α, β - amirine of 73%, 15%, and 10% respectively (Waters et al, 1990).

This effect is believed to be due to the antioxidant potential of the studied triterpenoid compound, already described in other studies, as evidenced in the literature. In vitro studies have shown that triterpenes have anti-cancer effects on about 26 hematological markers, which would explain the reason why there was a significant decrease in the frequency of micronuclei observed at 10 mg/kg concentration (Fabiyi et al. 2012).

The results obtained are similar to those found in the literature, Carneiro et al. (2017) describe, in his study that he used Astrocaryum aculeatum oil, an antigenotoxic activity that varied from 35 to 38% in 24h and 63 to 66% in 48h, observing a slight increase of the percentage of protection of genetic material against the DXR administered in the analysis made 48h after administration of the concentrations, which is due to the protective effect of the administered compounds, which were able to further reduce the effects of DXR even during the peak of genotoxicity in 48h (Okoye et al., 2014).

Besides the antigenotoxic effect, other characteristics are attributed to α, β - amirine. Mainly anti-inflammatory effects are described, but there is also an anti-nociceptive effect both when administered orally and intraperitoneally. Some studies have pointed out an anti-hyperglycemic and hypolipidemic effect, although the physiological mechanism that corroborates this effect is not known (Aragao et al., 2008).

The results obtained in the analysis of the bone marrow, which are described in Table 2, were also similar to those described in the literature. A high level of significance was observed in the treatment performed at a concentration of 10 mg / kg p.c, thus showing, as well as data from the analysis of peripheral blood, that treatments with lower concentrations were not able to produce significant effects to decrease the frequency of micronuclei found, becoming the percentage of reduction statistically similar to the Controls that used DMSO. Nevertheless, it is important to note that despite the significant decrease in the

percentage of reduction observed in the analysis of peripheral blood and bone marrow (67% in 24h and 73% in 48h in peripheral blood; 30% and 33% in 24h and 48h respectively, bone marrow), it is still considered a high percentage of protection, especially when observing the dosage administered, which in this study was substantially lower than other previous studies, a fact that makes this study so relevant (Okoye et al., 2014; Aparecida et al., 2006).

Table 2 – Nuclear division index and absolute and relative frequency of micronuclei found in peripheral blood and bone marrow in the period of 24h and 48h after Antigenotoxic treatment with α, β - amirine + DXR, by each group. 10,000 cells were analyzed for each group.

Treatment	IDN	MNEPCs		Reduction
	Peripheral Blood			
	Mean and deviation	N	%	%
CN 24h	0.060 ± 0.0071	14	0.14	-
DXR 24h	0.1 ± 0.0045	78	0.78	-
DXR + DMSO	0.066 ± 0.0054	59	0.59	29%
1mg/kg b.w. + DXR 24h	0.063 ± 0.0044	73	0.73	11%
3mg/kg b.w. + DXR 24h	0.062 ± 0.0044	70	0.7	12%
10mg/kg b.w. + DXR 24h	0.066 ± 0.0054	35	0.35	67%
CN 48h	0.056 ± 0.0054	14	0.14	-
DXR 48h	0.10 ± 0.0044	78	0.78	-
DXR + DMSO 48h	0.062 ± 0.0044	59	0.59	29%
1mg/kg b.w. + DXR 48h	0.064 ± 0.0054	72	0.72	9%
3mg/kg b.w. + DXR 48h	0.062 ± 0.0046	68	0.68	15%
10mg/kg b.w. + DXR 48h	0.061 ± 0.0042	31	0.31	73%
	Bone Marrow			
CN 24h	0.060 ± 0.0071	13	0.13	-
DXR 24h	0.11 ± 0.0045	150	1.5	-
DXR + DMSO	0.066 ± 0.0054	128	1.28	16%
1mg/kg b.w. + DXR 24h	0.063 ± 0.0044	134	1.34	11%
3mg/kg b.w. + DXR 24h	0.062 ± 0.0044	129	1.29	15%
10mg/kg b.w. + DXR 24h	0.066 ± 0.0054	109	1.09	30%
CN 48h	0.056 ± 0.0054	12	0.12	-
DXR 48h	0.10 ± 0.0044	163	1.63	-
DXR + DMSO 48h	0.062 ± 0.0044	133	1.33	19%
1mg/kg b.w. + DXR 48h	0.064 ± 0.0054	138	1.98	13%
3mg/kg b.w. + DXR 48h	0.062 ± 0.0046	126	1.26	16%
10mg/kg b.w. + DXR 48h	0.061 ± 0.0042	100	1	33%

The values are presented as mean ± S.D. and analyzed by ANOVA and Tukey's test.

Conclusion

Cytogenetic studies are not the only studies necessary for the implementation of new drugs on the market, but they are an important guiding parameter that indicates a path to be followed. The results clearly show the mainly genotoxic potential of the compound studied, evidenced in the highest concentration administered, obtaining up to 73% protection in 48h compared to the administered DXR, when the effect is evaluated on peripheral blood and 33% in 48 hours when the bone marrow evaluations were observed. The effects observed in this study and the literature show the great pharmacological potential of the compound α, β - amirine, which has many activities not even explained in the literature. It's also important to mention that the dosages were minimal compared to previous results already mentioned and the similar results show that the treatment, although in a reduced dosage, could provide similar results, which represents a considerable advance in research involving the studied compound. Being able to provide in the future a less aggressive treatment based on an Amazonian product that can be extracted with a certain ease, in addition to being a plant not exactly Amazonian, but that occurs in a large part of the national territory. Therefore, it is worth emphasizing the importance of continuing studies like this, which aim to add knowledge to Brazilian society, especially Amazonian, which has so many plants of medical interest available for the production of drugs for treatment not only in the area of oncology but also in the several pathologies.

Conflict of interest

The authors declare no conflicts of interest.

Author Contributions

Lucas Rodrigues do Rego designed the study, performed the toxicity, Cytotoxicity, Genotoxicity and Antigenotoxicity assays, and drafted the manuscript. Everton Pantoja Vale assisted in Micronucleus test. Danilo Dheyvison Nascimento Pureza assisted in Micronucleus test. Moacir de Azevedo Bentes Monteiro Neto designed the study, drafted the manuscript, and interpreted the data.

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Education in rights and citizenship instruction: epistemic elucidation as from Paulo Freire

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Abstract

Education is undoubtedly a factor that contributes decisively to human development. In this sense, the present study searches to evaluate, based on freirean assumptions, the contemporary scenario of education in Brazil and its reflexes in society. From a historical and structural analysis, the problems that are established as impasses to a contextualized, plural and accessible education are put in check, as we think new paths, from the epistemology of Paulo Freire, for the real performance of students in human rights and citizenship.

Keywords: Paulo Freire; Human Rights Education (HRE); citizenship; law.

1. Introduction

The debate surrounding the appliance of Human Rights Education (HRE), in Brazil, is propelled by the insertion of themes connected to citizenship, democracy and diversity on the different levels, formal and non-formal, of education. Beyond the existence of methodological questions, the mentioned subarea of knowledge contributes to reflect on the complex social issues that establish themselves, overall, from different processes and practices of power and exclusion. Therefore it contributes, decisively, to the placement of education as an instrument of social change (Silva, 2010).

This way, education, legally recognized as an entitlement of the population, must not end in itself. Such right chains the perception that it is necessary to qualify the formative process, in a way that human education happens in its emancipator character that prepares people to intervene upon social problems. Therefore, within the study of HRE, it is necessary the rupture with the banking education (Freire, 1987), meaning, with the acrytical and apolitical educating method, mirror of the neoliberal teaching method.

In the face of the aforementioned, the present study aims to revisit some of the presuppositions presented by Paulo Freire. The contributions of the aforecited author compose, by this perspective, a set of atemporal knowledge, explicitly and implicitly connected to the HRE, and that must be revisited. The tensioning presented by Freire about the observation and ressignification of the world and surrounding the social relevance of education, particularly highlight the fundamentality of HRE in contemporaneity, and the permanent reconstruction of principles connected with the education on diversity and citizenship.

In this matter, the general objective of the following research is to reflect upon the intersections amongst social change and the education in human rights, based on epistemic presuppositions present in the Paulo

Freire pieces. Therefore, to reflect on HRE implicates in checking relevance and enlarging the premises previously formulated by Paulo Freire that might get signified nowadays as a way of thinking about the social issues with which educators deal.

Questions such as: is it possible to get over the common and acritical sense introduced by the the neoliberal educational model?; in which way, as an educator, is it possible to turn the transmission of knowledge aligned with the society and more inclusive?; and beyond that, in which way, as a politically conscious person, may we guarantee that other people can critically see the reality in which they're inserted in?; guide the research.

2. Materials and Methods

The method used in the development of the following research was the deductive (Gerhardt & Silveira, 2009). From this line of thought, it will be drawn an analysis of the HRE panorama in Brazil based on the theoretical wide fundamentals over its applicability and constitution, that might further on get singularized to context and particular situations.

As a qualitative approach (Zanella, 2013), in this research, it was of concern to problematize specific themes, subjects and institutions, dismissing the development of rigid speculations around the objective of the research. In that sense, the approach was used with the intention of understanding and interpreting, in a dialogic and opened to ressignifications, the work of Paulo Freire under a philosophical point of view.

The types of research applied are from exploratory and descriptive character (Zanella, 2013), concerning the deepening of the bibliography. At the same time that the research implies the reflexive (re)discovery of the presuppositions of Paulo Freire - from the bibliographic review of its works and commentators - it is opportune the characterization and organization of some of the central theoretical plea.

Therefore, the technique of data collection is the bibliographic research (Gerhardt & Silveira, 2009), that will fundament the reflections upon the HRE in Brazil and its connections to the freirean thought. The bibliographic research was organized based on books and other academic publications mapped from Google Academic, Scielo and BDTD/CAPES.

3. Results and Discussion

3.1 The education scenario in the contemporary Brazil

Currently, the main issues faced in the brazilian educational scenario refer to the tension and retrocess caused by the advance of conservatism and the recrudescence of the educational agenda, aspects that have reflected on the crescent social exclusion (Candau, 2007). It is worth it to highlight that this is not a result, exclusively, of the lack of public services, but as the intentional neoliberal project of power, that has disregarded the rendering of these services with each social reality of more vulnerable groups.

The severe violation of rights and the violence that have consolidated mainly during the dictatorship, though not only, have frailized the affirmation of rights, resulting from the fear and political apathy. On that matter, the brazilian population is marked by an educational process that established itself by the absence of elucidation in different axes connected to the HRE and the qualification of professionals that act on the promotion and protection of human rights (Silva & Tavares, 2011).

Not only globalization, the neoliberal politics and global security (Candau, 2007, p. 399) are also the main dimensions that install the social exclusion in its most varied extensions, especially the educational. For that reason it is needed for it to be given space to the discussions of pedagogical generator themes, because parting from them it is possible to evaluate the sociocultural, affective, experimental and structural dimensions of the educational process in the perspective of the critical pedagogy" (Candau, 2007, p. 408).
It fits to evaluate critically the neoliberal education and its highly excludent character, impenetrable to the new pedagogic conceptions relating to human rights. The HRE, in this sense, is presented as an antagonist to the intended neutral education that Paulo Freire had warned about previously. The HRE is the remnant ethical and the possibility of reflection on the violation and the marginalized groups, surrounding the restless rescue of the memory and mainly the recognition of the violence and injustice perpetuated by the State (Candau, 2007).
In such a way, the central question resides regarding the impasses of the efetivation of the didactic. Assuming that the lack of adequation of the curriculum to the guidelines in HRE, as well as the scarcity of supply, pedagogical practices and the fragile continuous education come as the main obstacles to the efetivation of an education with such characteristics. Considering the Law School courses in Brazil as an example, that have multiplied indiscriminately, it is shown a lack of preoccupation concerning the quality of the education of those future professionals whom will act, supposedly, defending social justice, since extremely dogmatic curriculum remain as the educational tonic (Carvalho, 2011).
Besides, the citizen education in human rights must be intensified in the instruction of those professionals and, beyond that, to be thought of in every context of the intervention. This way, it is necessary that there is a rupture with the hegemonic conception of the human rights, that vehement is present in teaching, contemplating insurgent knowledge that will add value to subjects frequently invisibilized by the knowledge hegemony (Lima & Lima, 2018).
It is fundamental that the subjects have, in the formal and non-formal educational environment, a truthful citizenship and humanist instruction, in order to be responsible to recognize themselves as holders of rights, assuming a real political and social conscience (Amaral & Amaral, 2018). Therefore, the neutralization of the critical thinking within education must not be taken as a political strategy.
From a conscient and critical instruction guided by HRE, it is inferred that the fight for equality by itself is not enough, due to specific contexts that agency singular realities and that, by itself, implicates in the offering of a different education. In that way, the active consciousness arises, sequentially, from the correct relation between citizenship, human rights and democracy (Silva & Tavares, 2011).
Considering the aforementioned, it is vital to evaluate the instruction of individuals in and to human rights, under the light of Paulo Freire's presuppositions. Through continuous and contextualized education, the search for alternatives to the issues that need to be reflected upon in the distinct instruction spaces takes place, and specially through the education of individuals more vulnerable, so it is possible to be offered subsidies to the social practice of the rights defense.

3.2 Epistemic presuppositions on the human rights education: freirean contributions

In Brazil, Paulo Freire has contributed to a singular aspect of the development of HRE. His acting took place, especially, from *Pedagogia do Oprimido* (1987) work in which outlines his main ideas concerning

popular liberation and the confrontation to authoritarian practices. His contributions, as they will be presented further on, were and still are extremely opportune, guiding different groups and individuals to the practice of citizenship that, in that historical context, related to the democratic transition and that undoubtedly apply also at contemporary themes.

In such a way, Paulo Freire developed educational strategies based on interdisciplinarity and daily experiences as alternatives to the rescue of rights. His thesis articulate instructive practices and beyond that, political and epistemic notions to the reparation of violence and to the recognition of denied otherness (Carbonari, 2007). This way, the instruction by and to citizenship is disposed in agreement with the processes of affirmation of human rights. It is the continuous and shared reflection that, in these terms, reinforces the necessity of the permanent vindication of assurance to new ways of repair and surpass cases of vulnerability and exclusion.

Regardless, to Freire (1987), it is of extreme importance to evaluate the daily appliance of instructive practices, in a way that didactic and teaching are implied with society and individuals, structuring dimension of HRE. On the matter, the awareness of the silencing of guarantees and the systematic exclusion are tonic of the experience of vulnerable groups and mobilize the political look and action, according to the author (Freire, 1967).

In which concerns the didactic strategies, in any educational level in which are mobilized, they assume the collective and participative work. In this logic, Freire (1987), reinforces political mechanisms to the dynamic social instruction and truthful citizenship, as conceived in the field of education of human rights (Silva & Cardoso, 2019). However, in order of an effectivation of a collective and participative work, it is fundamental the use of pedagogies that are compromised with the daily actions and consequently with other guidelines that allow, mainly to marginalized groups, the contextual consolidation of values, practices and attitudes that foment diversity (Tavares, 2009).

It is in such way that Silva and Tavares (2011, p. 20) allude to the conception of "active citizenship" aforementioned and that such idea "materializes in practice and in the social daily life, in knowledge of laws, dues and rights and in the way of demanding them and applying them in order to guarantee the access to social assets to all people". In this perspective, in dialogue with the freirean premises, it is necessary to consider the permanent process of awareness and that such instruction is truly democratic (Freire, 1967).

To Freire (1987), the education is conceived through the elaboration of programmatic content that are capable of recreating the dialogical bridge between educator and society. Then, in order to get over social issues, it is essential that new strategies are connected to respecting and valuing diversity are implemented based on the educational headquarters such as interculturality, interdisciplinarity, the value of sexual and gender diversity, the multiethnic knowledge and among others.

In these terms, Paulo Freire assigned bases to the HRE in the pacing he considered thematic universes that could adequate themselves to different social and humane contexts. It is encouraged that to these groups, the consciousness around themselves is fundamental to the process of mobilizing the knowledge. Such process values the 'conscious bodies' capable of overcoming what the author names as "limit-situations" (Freire, 1987).

To attribute importance to the freirean presuppositions overpowers the knowledge of rigid methodologies and apply them as a way of deconstructing limited notions of knowing. To conceive the application of those

presuppositions in the current context implies in deconstructing, daily, traditional narratives of the power-knowledge and translates itself in the assigned visibility to invisibilized groups, aiming to understand history and its repercussions in the current time. In this way, education is not a way of perpetrating segregation, but a constant practice of liberation (Freire, 1967).

Freire and Shor (1987), while discussing fear, articulated that the notion of active education means overall, to act critically and politically. It constitutes, in this sense, the comprehension of limits and the impasses that are imposed so that different individuals might act in a strategic manner, searching for ways to go forward and to consolidate the participation and the exercise of citizenship. This instructive process involves the valuation of narratives of time, space and social logic that need to be reflected upon.

If education is, in a way or another, a political strategy, it will assume, continuously, the liberation while fundamental principle of the educational action. In this sense, education is political: the individuals are, all the time, overcomers of their own fears (Freire & Shor, 1987). The fear, while silencing, is deconstructed and ressignified from the political standview.

The development of convictions and the certainty that they, truthfully, constitute the individual, forges the political process in education and vice versa. Freire narrated, as a metaphor to such an argument, his most fearful moments while politically captive during the dictatorship of 1964 and how each unknown threat caused him to paralyze (Freire & Shor, 1987). He affirms, equally, that he found balance in his 'ideological scale' in his feelings and wishes for social change and that such reflections came from his daily experiences of facing the fear of repression and with the continuous reflection of the reality.

The political instruction is, then, fundamented in an epistemic foundation that doesn't provide the individual elements of critical comprehension of reality. In such way, the critical and liberating education works as an antidote to plastered doctrines that present the fear as an instrument of social domination, since "the more you recognize that your fear is a consequence of the attempt of practicing your dream, the more you learn to put your dream in practice" (Freire & Shor, 1987, p 40).

It is meaningful to relate in contemporaneity, the plea presented by Freire and reinterpret his conceptions of 'fear' and 'dream', since today, those notions are conceived in a different manner. The fear might constitute, for instance, in the practice of teachers who venture in the appliance of critical methodology, enlarge and attribute different meanings to the curriculum. The dream, on the other hand, is architected through a black, quilombo community resident that contemplates to offer continuous education to their community on ethnic-racial relations, for instance.

The HRE didactic, from the epistemic premises by Freire, is organized from the relation individual-world relationship, because it concerns the decodification of the existential situation that surrounds a person. It assumes the capacity of acquiring a new posture before the limit-situation, which are reinvented from the convictions constructed and reconstructed on a daily basis (Freire, 1987).

It is worth it to consider, for example, the symbolic violence attached to the courses of juridical instruction post dictatorship in Brazil that began to offer acritical disciplines, that instigate the common sense, providing the maladjustment socio professional of the graduate, among other problems. In this area of issues it is enough to understand 'in which consists the knowledge reproduced and which way it is used to reproduce it" (Costa, 1992, p. 214).

It is necessary to comprehend the dialogue as a founding and natural axe to such didactic-instructive dynamics (Freire, 1987). The processes of analysis and reflection, though essentially individual, manifest based on the dynamic of knowing and teaching the language and discourse. The continuous exchange of analysis and reflection forge the dialogue and offers mechanisms to the formulation of new epistemologies, such as the problematizing in relation to the education in human rights. Therefore, the dialogue does not edify as mere technique, but in the naturality of how life and subjects flow (Freire & Shor, 1987).

In this perspective, the dialogic freirean education surpasses the daily activity of schools and universities. It constitutes itself based on daily practices that take the social problems as spaces of mobilizing the action and the knowing. In a wide manner, such dynamic substantiates the idea of active citizenship that installs itself through epistemologies of the dialogue (Freire, 1987).

In this dialectic, the language confers connection with the concrete, with the daily. The university, by imposing technical distance with the world, for example, enlarges the risks of the education being co-opted by neoliberal methods of educational instruction. It is in this sense that, currently, the profiles of instruction on the University education are articulate in "cognitive conception associated with the neutrality, of dogmatic character, eurocentric and universalist" (Goés Júnior, 2010, p. 5250), that drive away the university from the society. This type of symbology reaffirms the banking logic that Paulo Freire has criticized. The instruction courses of university education have become massive, and overall, distant from the social complexities, which constitutes as a pressing question for the instruction and democracy and to the stimulus to the citizen elucidation (Freire, 1987).

In such way, one of the current biggest pedagogic issues, perpetrated by the acritical education, does not ramify, essentially, through the danger of awareness (Freire, 1987), since such danger usually presents itself in explicit situations of authoritarianism. The problem comes from the unecessarity of veiled awareness, provenient from the neoliberal educational strategy, extremely technicist.

The critical education, though, does not demonstrate itself convenient to the spheres of power and does not become comfortable to unprepared professionals. It is pertinent to understand that the quietness will never be emancipatory and therefore the reinterpretation of the freirean epistemologies makes itself necessary. It is essential to be alert to the anti dialogic and conservative strategies, since they conquer, divide and manipulate, each time more people. It is necessary then, to educate to generator themes and to the memory, in a way which the individuals politically reinvidicate (Ferreira, 2007).

5. Conclusion

The presented questions in this research constitute themselves, essentially, from the tensioning regarding the instruction to democracy, to the valuing of human rights and its right articulation with the processes of citizenship in HRE. Under this optic, the analysis of some central concepts presented by Paulo Freire in *Educação como Prática de Liberdade* (1967), *Pedagogia do Oprimido* (1987) and *Medo e Ousadia: cotidiano do professor* (1987) offer epistemic subsidy to the referred subarea of knowing.

To revisit arguments such as *banking education, limit-situations, danger of awareness, democratic awareness, the substitution of fear for dream, strategic education, dialogicity, education as a practice of freedom*, enables us to learn to resignify such dominating practices to possible strategies to overcome them.

From these notions, it is plausible to assign meaning to current issues, at the same pace it is possible to comprehend the importance of HRE as a permanent education dispute in favor of democracy and reaffirmation of rights.

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Machine Learning and Finance: A Review using Latent Dirichlet Allocation Technique (LDA)

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Abstract

The aim of this paper is provide a first comprehensive structuring of the literature applying machine learning to finance. We use a probabilistic topic modelling approach to make sense of this diverse body of research spanning across the disciplines of finance, economics, computer sciences, and decision sciences. Through the topic modelling approach, a Latent Dirichlet Allocation Technique (LDA), we can extract the 14 coherent research topics that are the focus of the 6,148 academic articles during the years 1990-2019 analysed. We first describe and structure these topics, and then further show how the topic focus has evolved over the last two decades. Our study thus provides a structured topography for finance researchers seeking to integrate machine learning research approaches in their exploration of finance phenomena. We also showcase the benefits to finance researchers of the method of probabilistic modelling of topics for deep comprehension of a body of literature, especially when that literature has diverse multi-disciplinary actors.

Keywords: Machine Learning; topic modelling; structuring finance research; latent dirichlet allocation

1. Introduction

The techniques of Machine Learning (ML) and Artificial Intelligence (AI) offer significant benefits to financial decision makers in terms of new approaches to modelling and forecasting from data. This has been recognized by the finance industry, with about $41 billion annually expected to be spent globally by the finance firms on artificial intelligence technologies by 2022 (IDC, 2018; Sezer & Ozbayoglu, 2018; Zetzsche, Dirk; Arner, Buckley & Tang, 2020). Key current finance artificial intelligence applications are in algorithmic trading, risk management, and process automation. However, research on these topics among finance researchers has lagged practice. In this paper we therefore comprehensively structure this body of literature for the benefit of researchers seeking to understand the techniques and areas of interest of machine learning and artificial intelligence in finance.

For common understanding we first briefly give our working definitions of artificial intelligence techniques. Artificial intelligence (AI) is an umbrella term for a range of techniques involving intelligence

demonstrated by machines, with this intelligence normally focused on prediction. In a finance context, due to its numerical focus, the most relevant AI methods have been machine learning (ML): predictive algorithms and models involving statistical learning from data; and more recently deep learning (DL): an approach that allows more abstracted learning from unknown relationships within the input data. DL is an approach that has evolved from an earlier focus on artificial neural networks. Throughout this paper we generally refer to ML and DL under a combined term of ML, as DL is a sub-field of ML. Of additional relevance in the toolkit of AI is natural language processing (NLP), centred on the understanding and analysis of textual data. NLP offers the potential to integrate the large body of textual data in learning and prediction and overlaps with ML to the extent that ML techniques can be applied to NLP data. The technique applied in this study, topic modelling, is an ML application of NLP, thus adding an element of symbiosis to our study with the use of an ML technique to understand research on ML in finance.

The potential for ML in financial decision making was, to our best understanding, first explored from a research perspective in Hawley et al. (1990) with a focus on neural networks as an aide to financial decision-making. Echoing its future benefit to banking, several early studies also appeared in the Journal of Banking & Finance in the 1990s which explored the potential for ML to improve lending decisions and credit risk management. Altman et al. (1994) applied neural networks to classify Italian firms based on likelihood of financial distress, while Varetto (1998) built on this study by applying genetic learning algorithms to the same topic. More recent research in finance journals has kept the focus on prediction but moved to- wards deep learning techniques and other advanced ML techniques. These recent applications include: the understanding of default recovery rates (Cheng & Cirillo, 2018); learning optimal option hedging rates (Nian, Coleman & Li, 2018); modelling investor sentiment (Renault, 2017); and the detection of stock price evolution based on order books (Zetzsche, Dirk; Arner, Buckley & Tang, 2020).

As finance journals have made tentative steps to acknowledging the potential of the new techniques of ML in finance, other disciplines have been making more stri- dent efforts to apply ML approaches to financial data. In part, this is due to the attractiveness of the comprehensive, structured, and easily accessible, data available in finance. Indeed, research on ML and finance outside of finance journals exceeds by a considerable multiple ML and finance research in finance journals. Some recent examples of this outside-finance corpus of ML in finance research include the application of image recognition techniques for the prediction of stock technical patterns (Sezer & Ozbayoglu, 2018), forecasting stock prices based on ensemble models of online search and sentiment data (Weng, Lu, Wang, Megahed & Martinez, 2018; Aziz, Dowling, Hammami & Piepenbrink, 2019), and bank risk modelling (Cerchiello, Giudici & Nicola, 2017).

This multi-disciplinary development of ML and finance research presents challenges to researchers seeking to understand the corpus of research in the area. The literature spread also risks duplication of research and incomplete inputs into idea development. Further, as the body of research is substantial - we identify 6,148 studies in ML and finance - it is beyond reasonable human capabilities to comprehensively understand the directions and topics of this research. For this reason, we adopt a topic modelling approach that enables probabilistic learning of the core topics of ML and finance across the main disciplines in which it is

researched. The topic modelling approach also allows following the evolution of these topics over time. This thus provides both a comprehensive and trend-based understanding of the structure of research in this area.

We apply a Latent Dirichlet Allocation (LDA) approach (Blei & Jordan, 2003; Blei, 2012; Aziz, Dowling, Hammami & Piepenbrink, 2019) to topic modelling. LDA works off the assumption that each document is a collection of (hidden) topics and the words used by authors represent those topics. Probabilistic inference is used to identify these topics from the collection of words in a document, and subsequently to identify the most relevant topics across a corpus of documents. A core advantage of the technique, compared to other approaches to surveying a literature, is that no prior knowledge of topics is needed. Take a simple example where, from a sufficiently large corpus of documents, the extracted set of terms consists of just three words across the entire corpus: [river, bank, money]. LDA should be able distinguish this into two distinct topics of [river, bank] and [bank, money] recognizing the dual meaning of [bank]. The approach, which is detailed in the following section, is therefore recommended for its ability to arrive at distinct topics.

Previous topic modelling in other business disciplines has recently appeared in the literature, including on how emerging markets are researched (Piepenbrink and & Nurmammadov, 2015) and on the structure of approaches to organization research methods (Piepenbrink & Gaur, 2017). It has also been applied in practical business contexts, such as determining patent topics (Kaplan & Vakili, 2015) and under- standing online brand discussions (Tirunillai & Tellis, 2014; Aziz et al., 2019). There has been a limited amount of topic modelling applications of closer relevance to finance, but not quite in finance. These include Moro et al. (2015) who grouped a small number of articles (219) into topics on the application of business intelligence to the banking sector, and Dyer et al. (2017) who determine 150 topics in US 10-K annual reports. Our study makes several contributions. It is the first comprehensive structuring of the ML and finance literature. There have been some more limited prior reviews of this literature, including Heaton et al. (2016) who structure the deep learning and finance prior research, and Wong and Selvi (1998) who provide an early review of neural network applications in finance. There have also been some comprehensive reviews on ML as applied to economics (Mullainathan & Spiess, 2017; Athey, 2018). However, perhaps because of the scale and spread of the literature, the full literature on ML in finance as researched across disciplines has not been previously structured.

Our study is also the first application of topic modelling to the finance literature. This is important as the technique offers benefits to financial research comprehension. Financial research tends to be spread not just among finance journals but also, because of the transferable quantitative training of finance researchers and the attractiveness of ordered financial data as a data source, across a range of other disciplines. This makes it difficult to arrive at comprehensive understanding of the full body of research in an area of finance. We suggest that topic modelling is an important means of addressing this spread problem. To finance researchers, we also contribute to an overall sense as the application of ML to finance is of clear business importance but is relatively understudied by financial researchers. Instead, it is the primary domain of computer scientists. This imbalance is not a problem but does suggest that pertinent financial insights to

the research might be being missed. By providing a structure to the topics of this research field we allow finance researchers to become familiar with the areas' structure as well as the approaches to research within each topic.

2. Background

2.1. Topic modelling through Latent Dirichlet Allocation (LDA)

Topic modelling is a process for discovering the 'hidden' or latent topics in a corpus of documents. There are a range of feasible approaches for this, including Latent Semantic Indexing, Probabilistic Latent Semantic Analysis, and Latent Dirichlet Al- location. The most widely accepted current approach is that of Latent Dirichlet Allocation (LDA) developed in Blei et al. (2003), due to the advantages of the incorporated Dirichlet distribution in assigning documents and terms to topics compared to older approaches. The practical advantage of LDA is that it allows individual documents to be a umixture of topics, and terms can belong to more than one topic. This echoes the reality of how corpora of documents are structured, as well as recognizing that topics within an area can partially overlap.

A summary of the LDA approach to topic modelling is that it assumes a fixed number of hidden topics in a corpus of documents, uses word co-occurrence to determine what these topics are, and then makes a probabilistic determination of the presence of these topics in a document. The perspective is that writers will approach writing a document with a collection of topics in mind and the words chosen will reflect this topic mixture. Thus, an article applying neural network approaches to credit risk modelling in banks might be written with a topic mixture of 50% credit risk modelling, 30% neural network methodologies, and 20% banking context. The choice of words in a document will then reflect this mixture of topics and their relative emphasis. The key task for the topic modelling researcher is therefore to work backwards from the observed words to uncover the latent topics.

A necessary first step in topic modelling is processing the corpus of documents. We describe this approach now, before proceeding to present the process for topic generation. Documents are initially processed by tokenizing each document into a collection of their individual words where order is unimportant (known as a 'bag of words' approach). Common 'stop words' that have offered no topic context (words such as 'and', 'of', 'the') are removed. Remaining words in a document are stemmed to reduce the unique word count further and accurately gauge unique term usage. That is, suffixes are removed to create common stem terms, e.g., both finance and finances might be reduced to the common financ stem. A TF-IDF (Term Frequency - Inverse Document Frequency) assessment is now made of the relative importance of the remaining words in the corpus (Salton & Buckley, 1988). This process involves first calculating the percentage of occurrences of a term in a document compared to all terms in that document. This is then multiplied by the log of all documents in the corpus divided by the number of documents in a corpus that contain the term. Higher TF-IDF terms are more relatively important in the corpus and lower TF-IDF terms are less important. Very low TF-IDF terms tend to now be removed due to being too uncommonly present in the corpus to be able to describe a topic. Similarly, but for the opposite reason, very high TF-IDF terms

tend to be removed due to being too widely used to be able to describe individual topics. Thus, for example, the term equity might occur in most investment papers and thus not be a useful term for understanding sub-topics within that area. In a research context this will also normally involve removing research structural words such as results, hypothesis, and analysis, which while not common in a general word usage frequency are very common in a body of academic research studies.

The final dataset after the TF-IDF stage, referred to as the document-term matrix (DTM), is a matrix structured as rows representing each document and columns representing each term, with values being frequency of occurrence of a term in a document.

Thus, from a corpus of 5,000 documents with 25,000 terms remaining after cleaning will result in a 5,000 * 25,000 dimension DTM. Topic modelling involves reducing the dimensions of this matrix to end up with the same number of rows / documents but a restricted number of columns which now represent the topics. A 20-topic LDA on the above example will thus result in a 5,000 * 20 matrix with values being the probabilistic weighting of each topic within each of the 5,000 documents. In turn the 20 topics will be a probabilistic weighting of each of the 25,000 original terms within each topic. This weighting allows two rankings to emerge. The first is the ranking of terms of importance to a topic. We commonly use the ten most important terms to describe a topic aiming for these ten terms to explain about 80-90% of the occurrence of that topic. We can also rank documents in the DTM to determine the documents that most purely match a topic. This is useful for identifying exemplar documents for a topic and for structuring documents within a corpus.

The process for LDA is well described in Blei (2012) and in more technical detail in Blei et al. (2003) and Boyd-Graber et al. (2017), so rather than repeating the technical detail we describe the intuition behind the process here using the plate diagram in Figure 1, as is common convention in describing relationships within algorithms in data science. We start our analysis with just the shaded circle, *w*, available which are specific words from each document in the corpus.

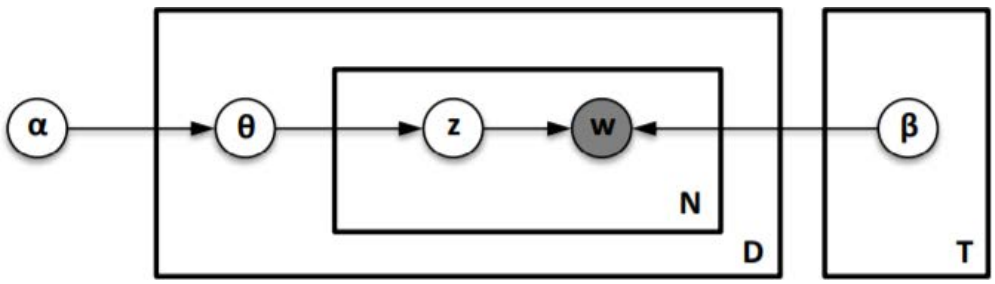

Figure 1: Latent Dirichlet Allocation plate diagram.

Sources: Kaplan and Vakili (2015); Aziz, Dowling, Hammami and Piepenbrink (2019)

All other variables (in circles) must be constructed or uncovered. N is the collection of all words w in a corpus. There are D documents d in the corpus and T topics t. A variable being in the N, D, or T plate indicates what form of the data that variable refers to. α and β are the Dirichlet priors and are the key external input into the model to determine the generative process of the LDA. α is the parameter for per-

document topic distributions, and β is the parameter for per-topic word distribution. A Dirich- let distribution is a distribution that can be used to produce probability vectors1 that allow in the LDA an assumption to be made about how topics are distributed across documents and words. A high α assumption indicates that each document in the corpus is likely to contain a distribution of most of the topics in the corpus and a low α indicates each document will contain only a few of the topics in the corpus. Similarly, a high β indicates that each topic is likely to contain a distribution of most of the words, while a low β indicates that each topic contains just a few of the words. The Dirichlet distribution thus gives the prior distributions across which we can approach latent topic discovery. The subsequent step in the model involves Bayesian updating to these priors based on actual word distribution across topics and documents.

Referring to Figure 1 again, α informs the initial θ which is the proportion of topics per document. The initial proportions are semi-randomly allocated according to the α Dirichlet prior. Following the plate diagram arrows, θ then informs z which is the actual topic assignment of words in a document. Separately β feeds into topic distribution of the words, which are also semi-randomly allocated initially according to the Dirichlet prior. Inferring from the model, which in its initial form is intractable, is by means of a choice of inference algorithms. The two popular choices are variational expectation-maximization inference as proposed in the initial Blei et al. (2003) paper, and Gibbs sampling proposed by Griffiths and Steyvers (2004). These inference techniques allow updating of the model from its initial semi- random allocation of topics to words and documents to a converged determination of probabilistic topics per document and across the corpus.

We now proceed, in the next section, to describe our corpus of ML and finance articles, our pre-processing choices undertaken to generate the DTM, and the LDA modelling options applied to the topic extraction.

3. Method

We use the Elsevier Scopus database to identify relevant prior research on ML in finance based on term searching within title, abstract, and keywords. This was a process of experimentation in terms of identifying suitable search terms where we had to iterate towards the best search terms. Our search criteria required a match of both a machine learning and a finance term, but in initial searches we were retrieving significant intruder articles with the combined terms of, for example, neural network and bank, where the resulting articles were about the application of neural networks within image banks for improved image recognition. An advantage of the topic modelling approach is that the presence of intruder articles is clear from the topics generated, as these articles clustered in topics that are clearly not related to ML in finance. Our final search criteria, which minimized, but didn't fully eliminate, intruder articles were as follows in Table 1:

Table 1. Search criteria

Machine learning search terms (4)	1) machine learning 2) artificial intelligence 3) support vector 4) deep learning 5) neural network
Finance search terms (14)	1) finance 2) investment 3) stock market 4) stock market 5) investor 6) equity 7) commercial bank 8) investment bank 9) credit institution 10) fixed income 11) debt 12) financial derivatives 13) financial crisis 14) risk management
Date Range	1990-2019
Publication type (2)	1) articles 2) conference papers
Source type (2)	1) journals 2) conference proceedings
Language	English language only
Subjects (5)	1) computer science 2) business 3) management and accounting 4) decision sciences 5) economics, econometrics and finance

After determining good term combinations, we experimented with some other variations of search terms for both ML and finance and did not find significant article count variation, suggesting a reasonable convergence on a suitable body of identified research. The date range start period was a feature of the research available, and the end point is October 2018, when we ran our last search update. We included conference papers published in conference proceedings in our sample as this is the primary mode of research communication in computer science, in contrast to finance practice, due to the need for speedy communication. Lastly, we limited the subjects to the Scopus subjects of computer science, decision

making, and business and economics to avoid topic sprawl. Our final dataset from this search process is 6,148 abstracts of articles which is the starting point for our analysis. Among the top journals which are popular for publishing ML and finance research are Expert Systems with Applications, Neurocomputing, European Journal of Operational Research, Quantitative Finance, and Journal of Banking & Finance. For pre-processing we used the R packages tm and Quantitative Analysis of Textual Data (*quanteda*). We performed the following steps: first, all text in each abstract is converted to lowercase letters, and digits and punctuation as well as stop words (words such as and, or, not, I, you) are removed. Second, we applied Porter's stemming algorithm that reduces each word to its stem (Porter, 1980). Third, we removed the top 10% of terms based on the TF-IDF score. The 10% choice was based on visual inspection of terms remaining and experimenting with between 5% and 15% top TF-IDF term removal. We also removed terms that occur less than five times in the corpus (low TF-IDF terms). Lastly, as the processing of the vocabulary leads to substantial shortening of the abstracts, so we only keep abstracts with at least five remaining terms. These pre-processing steps lead to reduction of the vocabulary in our DTM from 16,208 initial terms to 3,113 terms. Due to the length restriction on abstracts we keep 5,123 out of 6,148 abstracts. The final DTM therefore has dimensions of 5,123 and 3,113. The values in the DTM provide the number of occurrences of each term of the vocabulary in each document, with most of the entries being zero.

For the topic modelling itself we used the R package topic models (Hornik & Grün, 2011), with inference from the variational expectation-maximization algorithm as per the original Blei et al. (2003) process. The Dirichlet prior of α is set at 50/k where k is the number of topics. β is estimated within the model. These are the default parameters to estimate LDA models in the R topic models package, and there was no notable rationale for adjusting them. The number of topics k is the major input choice parameter for our topic model. We estimated topics for models for 15, 20, 25, 30 and 35 topics. As the resulting models do not necessarily find global extrema, for each k we run ten models with randomly chosen (but fixed across the various k) starting points.

This thus results in 50 sets of topic models (5 k parameters * 10 random starting seeds). For each set of topic models a Krippendorff's α (Krippendorff, 1970) is calculated where lower values of this α identify topic models with sharper topic distributions. We are guided by this value in choosing the final topic models to analyze, although not exclusively as we also manually inspect among the lower α topic models to choose which seems to be the most coherent in terms of individual topic composition. For this we inspected the top ten terms for each topic (the terms with the highest probability of attachment to a topic) and assessed them regarding their coherence as well as the top three abstracts with the highest fit to the topic (this fit being referred to as θ). The topic model with the most coherent topics and best fit of top articles was chosen, which is 20 topics and random seed 5 with an α of 0.1062.

4. Topics of Machine Learning and Finance

The topics extracted are contained in Table 1. Twenty topics are extracted in the preferred model. Of these we classify 14 as strong machine learning and finance topics, while the remaining six have either low coherency or are best classified as pure machine learning topics, and one is classified as a pure finance topic. In order to facilitate reporting of the results we assign a label to each topic that reflects the essence of the topic and based on our field knowledge we arrange the topics into three categories: (1) investment analysis, (2) asset modelling and forecasting, and (3) risk management. We now proceed to discuss the topics within each category as well as the overall category focus. Our analysis focuses on the top matched articles to each topic to provide an illustration of the topic content.

Table 2. Topics of machine learning in finance

No	Area	Topic Label	Top Ten Words	Cohesion	Top 3 articles and θ %	Fit	Average θ %
1	ML & FIN	Market Sentiment	detect, social, sentiment, event, news, media, fraud, text, document, opinion.	H	Smailovic (2014) – 95 Mukwazvure (2015) – 94 Ito (2018) – 93	H H H	5.61
2	ML & FIN	Neural network financial forecasting	firm,debt,list,rough,attribut,chines,per,ratio,rd,size	L	Lian (2015) – 92 Below (2000) – 82 Al-Qaheri (2008) – 81	L H H	4.61
3	ML & FIN	Forex forecasting	fuzzi,deep,logic,currenc,neurofuzzi, anfi,dimension,liquid,match,dolla	H	Yao (2000) – 95 Parida (2016) – 94 Abraham (2002) – 92	H H H	5.04
4	ML & FIN	Technical analysis	trade,ann,cluster,signal,trader, som,predictor,arima,selforgan,time seri	H	Ng (2011) – 92 Chavarnakul (2008) – 89 Kumar (2009) – 86	H H H	7.32
5	ML & FIN	Investor behaviour	agent,stage,analyt, phase,nn,distanc,big,multiag,cycl,cooper	M	Araujo (2010) – 88 Miglietta (2009) – 86 Moerland (2018) – 86	H H M	4.58
6	ML & FIN	Techniques for financial forecasting	ensembl,wavelet,transform,swarm, speed,particl,pso,	H	Ghasemiyeh (2017) – 87 Yiwen (2000) – 87	H H M	5.24

				propag,converg, oil		Nikolic (2016) – 87		
7	ML & FIN		Risk assessment	project,custom,game,ai,strateg, flow,cash,budget, player,schedul	M	Kumagai (2016) – 96 Yu (2011) – 95 Marmier (2014) – 91	L H H	4.81
8	ML & FIN		Energy forecasting	servic,energi,electr,manufactur, cloud,capac,maint en,grid,safeti, load	H	Huang (2013) – 97 Mishra (2012) – 95 Oprea (2016) – 94	H H H	4.88
9	ML		Environmental resource modeling	dss,region,water,environment,sensor,transport,infrastructur,urban, citi,spatial	H	Assaf (2006) – 89 Coventry (2011) – 88 Tulbure (2016) – 88	H H H	4.49
10	ML		Health diagnostics	health,imag,care,insur,medic,patient,recognit,digit,detect,hospit	H	Li (2012) – 94 Chen (2007) – 93 Dadayan (2007) – 92	H H H	4.14
11	ML		Innovative learning	softwar,univers,student,educ,question,behaviour,collabor,cours,feedback,acquir	H	Crain (2012) – 94 Wagner (2006) – 90 Villaverde (2006) - 87	H H H	4.64
12	ML & FIN		Portfolio optimization	portfolio,asset,alloc,hedg,stochast, svr,constraint,multiobject,bound, optimi	H	Chellaboina (2013) – 93 Shen (2017) – 92 Steiner (1997) – 91	H H H	5.89
13	ML & FIN		Investment decision support	expert,fund,properti,scheme,transact,recommend,profil,avail,privat, mutual	H	Kampouridis (2010) – 87 Tsang (2004) – 86 Jeon (2016) – 79	H H M	4.16
14	ML & FIN		Chaos and financial forecasting	option,layer,recurr,filter,valuat, neuron,onlin,nonparametr,evolv, recognit	H	Kim (1998) – 97 Medeiros (2007) – 85 Niranjan (1997) – 83	H H H	4.59
15	ML &		Operational	secur,identif,quali	H	Goh (2010) – 94	H	4.61

	FIN	risk management	t,modul,attack, ontolog,graph,hierarch,element, node		Zadeh (2006) – 91 Bhattacharya (2007) – 90	M H	
16	FIN	Financial analysis	enterpris,crisi,country,china, economi,polici,growth,corpor, govern,macroecon om	H	Wang (2011) – 93 Shaaf (1999) – 91 Huang (2011) – 91	H H H	6.07
17	ML & FIN	Credit risk modeling	credit,bank,score, commerci,loan, distress,bankruptci,discrimin,failur, custom	H	Waad (2011) – 94 Abdou (2014) – 92 Kim (2004) – 91	H H H	5.93
18	ML & FIN	Volatility modeling	volatil,svm,fluctuat,equiti,estat,multivari,kernel,sequenc,garch, svm	H	D'Cruz (2005) – 90 Liu (2012) – 87 Kumar (2012) – 86	H H H	5.32
19	ML & FIN	Risk forecasting	bp,logist,suppli,chain,ga,sector, bayesian,net,probabilist,cur	M	Mogre (2016) – 85 Wang (2009) – 82 Xu (2014) – 79	H H H	3.88
20	ML	Robotic processes	emerg,robot,mobil,internet,disast, electron,platform, locat,et,patent	H	Modelski (2010a) – 97 Modelski (2010b) – 97 Modelski (2010c) – 97	H H H	4.16

Notes: Table of topics determined based on extraction of 20 topics from 6,148 articles that match machine learning and finance search terms in Scopus. Grey rows are unused topics either due to low topic cohesion or topic not focusing on both machine learning and finance. Topic label is assigned by the authors. Top ten words are the stemmed words that best describe the topic. Cohesion is authors' assessment of how well the top ten words describe the proposed topic label. Top three articles are the articles that best match the topic label based on θ. Fit is authors assessment of how well each of the three articles fit within the topic. Average θ is overall coherency of the topics mapped to the articles. See Section 3 for further description on the methodology and explanation of choices made in the topic extraction.

4.1 Investment analysis topics

The first category, investment analysis, is the broadest of the three categories, per- haps reflecting general research in this category. We identify four topics in this category, all of which offer an interesting insight into potential future research directions. The four topics are: (1) market sentiment, (2) technical analysis, (3) investor behaviour, and (4) investment decision support.

The first topic is market sentiment (Topic 1 in Table 1). A popular machine learning technique in this topic is support vector machines (SVM) which are particularly useful for classifying data into groups. This, of course, is a common financial research task. Two of the top papers matching this topic use SVMs as part of their toolkit to classify the sentiment and tone of financial news stories (Ferreira et al., 2014) and news comments (Mukwazvure & Supreethi, 2015), although the latter study doesn't confine itself to financial news comments.

The highest matched article to this topic is Smailović et al. (2014) which shows that public sentiment based on Twitter feeds can be used to predict stock price movements. This has been a popular finance research area since the original Bollen et al. (2011) study. The model that Smailović et al. (2014) apply is interesting in terms of it being a mixture of SVM as a classifier for grouping tweets into positive, neutral, negative, but with a testing approach based on stream-based active learning. This approach moves beyond traditional machine learning where data is divided into training and testing groups (and similar variations thereof) and classification takes place in the training group and these classifications are then applied in the testing group. Instead, their approach takes advantage of the constant flows of tweets to allow their model to choose to update the classifier if it is experiencing particularly high uncertainty about new tweets. In this case the machine will request that these tweets are human-labelled as positive-neutral-negative so uncertainty can be reduced. Thus, the model is not just blindly applying the initial classification but is trying to identify occasions when it needs to be improved.

Other interesting studies related to market sentiment include Ito et al. (2017) who propose how to use unlabeled text data from stock message boards. The need to label text data for its sentiment tone is a particular and costly problem with using text. Also, Lumezanu et al. (2012) who model the behaviour of 'propagandists' on social media. They study an economic event of the US debt-ceiling crisis of 2011, but this could similarly be applied to distinguish between paid promoters of equities on social media and genuine investors.

Technical analysis (Topic 4) is, in contrast to the text-based market sentiment topic, primarily based on quantitative learning. The techniques are neural networks and increasingly deep learning variations of neural networks. Ng et al. (2011) approach the classic candlestick patterns of technical analysis with a combination of a Radial Basis Function (RBF) neural network and an improved error minimization technique. Their method seeks to distinguish between real and false bullish candle- stick patterns. Bullish candlesticks, in their most basic form, are where prices close the day near the daily high price, although Ng et al. (2011) apply ten different variations of bullish candlesticks, including multi-day patterns. The RBF in combination with the error minimization approach are used to train the model to distinguish be- tween bullish candlesticks that subsequently deliver either positive or negative 3-day returns. Testing on 10 years of Hong Kong stock data does show outperformance compared to a regular candlestick approach, although the testing is limited. Other papers applying neural networks to the technical analysis of stock prices include Chavarnakul and Enke (2008) who use a generalized regression neural network to predict from two technical indicators that combine volume and price signals, and Tilakaratne et al. (2007) who use

intermarket indicators.

Variations of reinforcement learning for technical analysis are applied by Dempster et al. (2001) and Hussain et al. (2016). Dempster et al. (2001) races reinforcement learning and genetic programming for popular technical indicators used in forex trading (such as relative strength and momentum oscillators). Reinforcement learning proffers the advantage over more basic forms of machine learning by allowing recurrent learning through goal setting. This study finds that genetic programming marginally outperforms in trading. The more recent Hussain et al. (2016) study applies recurrent neural networks, which are a form of reinforcement learning that is classified as deep learning. The study's particular technique is not to showcase the ability of recurrent neural networks to predict financial time series, but rather a new regularization technique developed to allow better organization of the hidden layer in the neural network. This illustrates the extent to which the application of ML to financial phenomena outside of finance research has moved on from a more basic conversation on the merits of ML techniques towards a fine-tuning stage. They show their technique results in significant predictive improvements over alternative ML techniques including multilayer perceptron neural networks in the prediction of a range of financial times series.

The topic of investor behaviour (Topic 5) fits somewhat to the extant literature on theoretical modelling of agent behaviour in finance. The fit for this topic is classified by us in Table 1 as 'medium' indicating that the topic extracted from the LDA is not fully coherent. Moerland et al. (2018) is perhaps the most useful of the top-matched articles to the topic, as it provides a review of prior literature on the role of emotion in agent / machine interaction, as well as delving into how to integrate emotional understanding in reinforcement learning models. With the projected growth of robo- advising, and the issues here around the need to develop an emphatic relationship between the advisee / robo-advisor, some aspects of this article would be useful in that regard. The article also highlights the extent to which AI researchers are fully aware of the need to integrate emotion in future technology. This idea is applied specifically to behavioural finance in Miglietta and Remondino (2009). They address a range of behavioural finance theories, but primarily concentrate on prospect theory. The issue they explore - for a computer science audience - is how to improve agent modelling in simulated behaviour considering these behavioural biases. The article itself is more exploratory than prescriptive indicating that these issues remained open for the intended audience at the time of the articles' publication, thus showing potential for collaboration with behavioural finance researchers. The last article we explore for this topic is Araújo et al. (2010) which is an attempt, based on acknowledging uncertain agent behaviour, to allow model flexibility to account for this uncertainty. They propose a variation on a multilayer perceptron neural network for this purpose.

The final topic in this group is investment decision support (Topic 13). This topic concentrates on the application of AI (in part ML, but also other aspects of AI) to generate information that supports investment decision making. The two highest matched articles to this topic both cover software called EDDIE, standing for Evolutionary Dynamic Data Investment Evaluator (Tsang et al., 2004; Kampouridis & Tsang, 2010). We concentrate on a more recent Kampouridis and Otero (2017) study in the subsequent discussion as it refers to the most recent iteration of the EDDIE algorithm (EDDIE 9). EDDIE builds on a genetic

programming approach, so is situated more within general AI rather than ML. The software is designed to support investment decisions by the application of genetic decision trees to arrive at simple yes/no or buy/don't buy answers to questions posed by the user such as whether a stock will rise by X% within n days. Of interest with this software, which is one of many examples of such software, is the extent to which it has grown in user flexibility with each iteration. The most recent version allows significant user customizability, while earlier versions were constrained by the strongly structured abilities of the initial algorithms.

Another application in this topic is Wang and Huang (2010) which addresses the issue of how to rapidly detect changes in mutual fund performance. For this they develop what they term a fast adaptive neural network classifier. The purpose of the 'fast adaptive' part of the neural network classifier is to allow new information to be constantly fed into the model and for it to subsequently update quickly. They show this speed output improvement in their study, comparing their model to a more standard neural network that needs to wait for significantly more information before it can efficiently update. A last interesting application under this topic by Mahalingam and Vivek (2016) is aimed at supporting a much smaller financial decision - that of automating how much a person can save given their spending behaviour. This illustrates some of the range in the investment decision support topic, and suggests some of the clear crossovers towards the FinTech industry.

4.2 Asset modelling and forecasting topics

Topics related to either asset modelling or asset price forecasting are the largest category of topics, with six of the 14 topics in this category. This is quite natural due to the emphasis on forecasting and prediction in machine learning techniques. The six topics are: (1) portfolio optimization, (2) volatility modelling, (3) forex forecasting, (4) energy forecasting, (5) chaos and financial forecasting, and (6) techniques for financial forecasting.

Portfolio optimization (Topic 12) is the first topic we explore in this category. Shen and Wang (2017) are one of the top matched articles to this topic. They address a classic issue with Markowitz-based portfolio selection that mean-variance portfolio estimation in practice requires long time periods of data to estimate input parameters. This, in turn, introduces the risk that data will not be relevant for current portfolios. Researchers such as Michaud (1989) have sought to address this issue by resampling recent pricing data through bootstrapping to avoid the use of older data, but without convincing success (Harvey et al., 2010). Shen and Wang (2017) address this issue using ensemble learning, an ML approach where multiple algorithms / sub-samples are tested to improve learning compared to a single ML application. A known advantage of ensemble learning is that even if individual algorithm applications are weaker than a single-application algorithm, their combined findings can outperform the single-application algorithm. The technique in Shen and Wang (2017) is a Bag of Little Bootstraps (BLB) to bootstrap sub- samples of equity data using short time periods, which when combined improve estimation errors for Markowitz input parameters. Other papers in this topic take alternative approaches to portfolio optimization, with Steiner and Wittkemper (1997) applying an artificial neural network, Ma et al. (2014) using a genetic algorithm,

and Chellaboina et al. (2013) applying both these approaches to hedged option portfolios. The next two topics in this category - volatility modelling, forex forecasting - have elements of similarity with their focus on forecasting asset pricing and volatility. We concentrate first on volatility modelling and forecasting (Topic 18). As is evidenced from the keywords for the topic, the ML approach to volatility modelling is to provide alternative methods for estimating volatility compared to standard techniques such as GARCH. Various neural network approaches are the most common ML techniques (Liao & Wang, 2010; Liu & Wang, 2012). Hossain and Nasser (2011) is a useful example of this topic, with their comparison of GARCH, neural networks, and SVM. While SVMs were originally developed for classification, as noted in the previous section, they can also be applied to regression type problems. In Hossain and Nasser (2011) they argue and demonstrate how SVMs applied to volatility forecasting strikes a better balance between training accuracy and testing accuracy than neural networks, and overall outperforms GARCH and neural network approaches.

Foreign exchange (forex) forecasting (Topic 3) is particularly attractive for ML practical application due to the clean structure of the data available. Thus, it has been used as a data source for testing a wide number of ML techniques, while there has also been a ML focus within finance research due to the common industry application of algorithms to trading forex markets. As demonstrated by the keywords for the topic, deep learning based fuzzy neural networks are a core focus of the application of ML to forex markets (Abraham, 2002; AmirAskari & Menhaj, 2016; Kodogiannis & Lolis, 2002; Parida et al., 2015). Yao and Tan (2000) also present a simpler neural networks model without incorporating fuzzy logic. Taking the most recent paper of the papers closely matching the forex topic, AmirAskari and Menhaj (2016), we see some of the benefits of the fuzzy neural network approach in forex forecasting. The paper builds on the core idea of blending fuzzy logic and neural networks through testing a new model called the Modified Fuzzy Relational Model (MRFM) which they argue should allow better modelling of dynamic systems such as forex relationships. The paper shows this (weakly) by comparison with a feed for- ward neural network, an RBF neural network, and an earlier type of fuzzy neural network (ANFIS). It is a notable paper as it highlights how far the literature has moved on from traditional finance techniques, where even the contrast methods to the new method being showcased are considerably advanced compared to a standard finance forex study.

The energy forecasting topic (Topic 8) is only briefly discussed here. The topic itself is very much at the edge between a finance, accounting, and pure energy topic. This itself is interesting as it shows how the methods of ML can blend these topics. The topic concentrates on estimating energy usage and therefore energy costs and how to minimize these costs (Huang et al., 2013; Mishra et al., 2012; Oprea, 2015). While this has some benefits in terms of modelling energy usage and as a contribution towards understanding economic environmental impact, perhaps the topic is also useful at demonstrating how well the LDA topic modelling approach can cluster similar documents together from a large disparate literature.

The last two topics in this category are: chaos and financial forecasting (Topic 14), and techniques for financial forecasting (Topic 6). These two topics have some similarities due to the focus on particularly

advanced techniques. In the first, the benefits of ML approaches to understanding chaotic time series are demonstrated. Ince and Trafalis (2008), among the highly matched papers to the topic, discusses the general issue with chaotic financial data and how ML approaches can help improve understanding. Kim (1998) and Rather et al. (2015) focus on recurrent neural networks as a means of modelling. Recurrent neural networks are proposed as useful as they allow some form of memory within the neural network, so there can be temporal connections, even if the overall time series is chaotic. Echoing this, the popular Heaton et al. (2016) paper (not a matched paper in our database as it has not been published) which overviews deep learning techniques in finance places an emphasis on a modern type of recurrent neural network: LSTM (Long-Short Term Memory) models. Other strongly matched techniques for this topic focus on the non-linearity aspect, with the testing of multilayer perceptron's (Medeiros & Barreto, 2007) and RBF neural networks (Niranjan, 1996) to help better model chaotic time series.

In the last topic in the asset modelling and forecasting category, techniques for financial forecasting (Topic 6), a variety of advanced techniques have been clustered together by the topic modelling. This includes varieties of genetic algorithms such as cuckoo searches: where the modelling approach is based on a cuckoo bird randomly laying eggs in a variety of foreign nests initially and then learning the best nests over time. Ghasemiyeh et al. (2017) applies this technique to stock price prediction. Worasucheep (2015) integrate an alternative optimization technique - Artificial

Bee Colony algorithm to model forex pricing, while particle swarm optimization is applied to model electricity pricing in Junyou (2007), and wavelets are applied in a short study by Yiwen et al. (2000).

4.3 Risk management topics

The third and final category of the topics relates to the area of risk management, for which we have four of the 14 topics. The topics are (1) risk assessment, (2) risk forecasting, (3) operational risk management, and (4) credit risk modelling. As noted in the introduction, risk modelling was one of the original focus on ML in finance, due to the strong methods in ML for classification and clustering. Classification is a particularly pertinent task for risk management, due to the broad need to classify acceptable and unacceptable risks.

The first two topics that we explore are risk assessment (Topic 7) and risk fore- casting (Topic 19). These two interconnected topics were a core focus following the global financial crisis, amid the seeming clear failure of traditional risk assessment and forecasting techniques. Our papers, however, cluster particularly around the nar- row field of the application of ML based approaches to the assessment and forecasting of risk related to projects. There is quite a strong overlap with supply chain research in terms of method and theory focus. There is also a focus on simpler techniques such as decision trees, which are used for classification in ML, but have a much wider use. A lot of the focus is instead on understanding the complexity within systems and managing that complexity. For instance, Marmier et al. (2014) introduces an integrated process through a decision tree model in new product development based on project risk. This system takes into consideration several risk activities along with other product development activities as part of project risk assessment that leads to the creation of a range of possible scenarios for a project.

Another top matching paper by Yu (2011) discuss the effectiveness of neural networks and game theory-based models of project risk assessment and management for large-scale long-term and high-investment projects. They model how neural networks can help manage risk in such a project.

While the risk assessment topic is largely theoretical in the scope of the matched articles, the research clustered under the risk forecasting topic (Topic 19) is quite applied. Mogre et al. (2016) proposes a decision support system-based framework to mitigate risk. Their approach encompasses identification, estimation, assessment, and decision making for risks. They apply their modelling approach to a case study of UK offshore wind farms and argue how their risk mitigation modelling strategies can reduce construction delays. Consistent with the Yu (2011) study in the risk assessment topic, the authors also suggest the usefulness of their proposed frameworks in the case of complex projects, as an enhanced level of complexity will usually foster a greater exposure towards risks. In a more direct ML application, Wang and Huang (2009) and Xu et al. (2014) focus on the preciseness and practicability of various neural network-based models in the context of risk assessment and risk forecasting.

Operational risk management (Topic 15) is the third topic of this category and represents perhaps the oldest and the newest threat that both financial and non- financial firms deal with. Operational risk refers to potential losses emanating from a host of operational breakdown linked to either an internal (e.g., inadequate or failed internal processes, people, and systems) or an external event (e.g., fraud, operational error) (Moosa, 2007). A difficulty is the sheer breadth of possible operational events, as opposed to the more easily defined other risk categories such as market and credit risk. A variety of AI and ML based risk management approaches have been applied to operational risk management. This includes a case-based reasoning approach to assess, identify and analyse operational risk (e.g., Goh & Chua, 2009) and an AI based risk management process for enabling an organization to insulate itself from serious system related security breaches (Bhattacharya & Ghosh, 2007).

The last topic identified for this category is credit risk modelling (Topic 17), a sub-area of the risk management category that demonstrates the most practical ap- plication of ML techniques, for financial institutions. There is also some data availability for studying credit risk modelling, an issue that has prevented the growth in study of the other topics in this category. As noted in the introduction, we started witnessing the use of ML techniques in credit risk models from the early 1990s with the comparison of neural network-based distress and bankruptcy prediction models with traditional statistical methods. Taking the classical linear, logit and probit regressions models proposed by Altman (1968) that dominated industry practice for decades, there was a clear and significant improvement observed in predicting defaults when traditional models were combined with the neural network-based models of credit risk starting with (Altman et al., 1994). Building on the start offered by Altman et al. (1994), Kim and Sohn (2004) tests neural network models to identify the misclassification of customers (good and bad borrowers) observed in classical credit scoring models. Also, Abdou et al. (2014) examines the robustness of three credit risk models including discriminant analysis, logistic regression, and multilayer perceptron neural networks, in the decision-making process of the Islamic finance houses in the UK. Their findings show that the neural

network approach outperforms the other credit scoring techniques. This success is on grounds of classification accuracy, on predicting the rejected credit applications, and on the cost of misclassifying borrowers.

The rapidly growing complexity of credit markets (such as the growth of CDS markets) and availability of new data (such as on consumer and small firm (SME) lending) has further widened the scope for ML techniques in the assessment and modelling of credit risk. Addressing this new complexity and new data is the focus of the last set of papers we discuss related to credit risk modelling. A good example is Son et al. (2016) who use a sample of daily CDS prices with varying maturities and quality over the period 2001 to 2014 and show that non-parametric ML models with deep learning outperform traditional benchmark models in terms of price prediction accuracy as well as in proposing practical hedging measures. Khandani et al. (2010) introduce an ML technique based on decision trees and SVM that leads to cost savings of up to 25 percent in the case of consumer lending, while Figini et al. (2017) propose a multivariate outlier detection ML technique that improves credit risk estimation for the SME lending portfolio of UniCredit Bank. As many of the studies already reviewed in the last three sections also indicate, they find that an ensemble approach to model building is particularly useful in improving model accuracy.

4.4 Topic evolution over time

As a last analysis, we track the evolution of our 14 topics over time. On a broad analysis of the chart, we see the most popular topics at the beginning of the time period were quite modelling-based. This modelling-based focus was seen in the discussion of the topics of operational risk management, investment decision support, and portfolio optimization. The recent most popular topics are much more data-based and forecasting-based, including market sentiment and technical analysis. This probably reflects the rise in data availability in recent years as well as new implementations of techniques based on the practical success they have demonstrated. The chart, however, needs to be viewed in conjunction with Figure 2 which showed very few ML and finance papers before about 2007. For that reason, it is probably best to compare the changes from the period marked 2005-2009 on the chart to the present day. Looking at the chart with this perspective we see a large growth in market sentiment studies over this period: Z from the least popular to the most popular topic. This might be due to the current focus in ML on the promise of textual statistical learning, as text is a key feature of ML market sentiment analysis. Technical analysis which has been strong in most periods, has dipped somewhat in popularity, and volatility modelling has also fallen in relative ranking. This might also be reflective of a move away from pure numerical analysis, as both technical analysis and volatility are almost exclusively based on numerical analysis.

This time period also shows large falls in relative popularity of topics for which there is still limited data availability including: investor behaviour, risk assessment, operational risk management, and even credit risk modelling (although that remains one of the more popular topics). This suggests that data availability is currently key in terms of topic popularity. Lastly, we see a strong recent rise in popularity in techniques for financial forecasting, perhaps due to the expansion in possible new techniques following deep learning breakthroughs that have expanded the universe of possible techniques that can be developed. The rise in

energy forecasting is interesting and is possibly because of an increased global research focus on optimizing and reducing energy consumption, as well as the increased grid complexity introduced by new forms of renewable energy production.

5 DISCUSSION AND CONCLUSIONS

In this study, we have provided a first finance application of topic modelling - a probabilistic technique for matching similar documents. Our demonstration with a diverse literature on the application of ML in finance shows the strength of this technique for holistically identifying and grouping relevant research on a topic. The 6,148 articles we identify are spread across the fields of computer sciences, decision sciences, economics, econometrics, and finance, and other business disciplines; yet we show how the LDA topic modelling technique can cleanly structure this diverse corpus of research into coherent topics.

Apart from the introduction of topic modelling to finance, the core contribution of this paper is the actual mapping of the ML in finance literature. Only a small fraction of the application of ML to financial problems is published in finance journals, despite the innate need within finance to continuously improve forecasting and modelling techniques. To some extent this is an existential issue for finance research, as industry practice in finance moves far beyond the techniques of traditional finance. Our mapping, provided in summary form in this paper, but with the full mapping for individual papers to topics available in a provided online repository, shows the structure of this literature for researchers in these topics seeking to augment their current research with the techniques of ML.

We identify three overall categories of topics: investment analysis, asset modelling and forecasting, and risk management, as well as 14 topics spread across these topics. These three categories, while sharing some techniques, are progressing at different speeds. Risk management, thanks to an early research lead, is well advanced in machine learning application of the modelling of risk. This is seen in the practical field of credit risk modelling to support bank and other financial institution lending decisions. However, the area is currently suffering from the rise in importance of data, with most relevant data being held privately by firms for their own internal use. Asset modelling and forecasting is also advanced due to the early understanding of the suitability of neural networks for modelling financial times series. Also, of help in this category has been the use of the clean datasets of financial time series as sample applications of machine learning techniques by non-finance machine learning researchers. Less advanced, but possibly more promising, is the category of investment analysis. In this category lies the promise of new data generation, such as on investor sentiment, behaviour, and the forecasting of fundamental finance variables. Our analysis of topic research over time, shows investor sentiment to be one of the main growth categories. This category opens the potential for the future of finance with applications such as robot-advising and other financial advisory services. It also relies on textual statistical learning for which methods of analysis are currently rapidly advanced.

Of additional interest are the topics of finance that are not yet addressed by machine learning, particularly

around corporate finance and the roles carried out by investment bankers such as mergers and acquisitions, and firm financing decisions. This does not mean that research is not being conducted within these areas, but just that the research is not of a sufficient quantity to be categorized as a self- standing topic. One major issue here is likely to be availability of data to study the issues, like the problem with ML in risk management research. Finance research in general has quite limited access to data within firms and within investment banks, instead being limited to externally observed data about the activities of these organizations. Research that can access this privately owned data within firms is needed to open this area. Also missing as a topic is financial network analysis, a large focus of the broader AI research movement. This probably reflects that there are quite limited datasets available for understanding the impact of networks on financial behaviour. There is also scope for textual analysis to expand outside of just market sentiment. Financial activities are heavily documented activities, and as the ML techniques of textual analysis improve, we should see greater focus on extracting knowledge from these data reservoirs.

We conclude on a note of optimism about the potential to expand the financial testing repertoire to incorporate the techniques outlined by this paper. The field of financial research has always been driven by the need to be practically relevant to financial practice. Our research thus has offered the finance industry in the past implementable approaches to investment selection and trading, applied corporate financing approaches, and developed new financial products and services. This is, of course, just a minor snapshot of what finance research has practically produced for the finance industry. Machine learning, as demonstrated in this research, is the logical next step of the finance researcher toolkit, due to its strong emphasis on practical understanding. We hope that the structure provided in this study offers some guidance as to how to incorporate these techniques suitably in future research.

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Analysis of Management in Health and Safety at Work Related to Employees Working in Health Teaching / Research Laboratories in a University

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Abstract

The search for always providing the best environment for its employees and students, allowed a university to open its doors for an evaluation regarding issues of health and safety at work, a very controversial topic, which leads many companies to close their doors and not accept this kind of "invasion" in your privacy. In this assessment, it can be seen that it is a favorable working environment for users, as their SESMT always looks for improvements and complies with the legislation, but there were also points to improve.

Keywords: Health. Work safety. SESMT.

1. Introduction

Working in laboratories is an activity that requires a lot of attention and strictly following the established good practices, each type of laboratory has its particularities, so it must have its own biosafety manual, available to users. According to MASTROENI (2006, p.3), every laboratory user, whether he is the responsible technician, professor or student, must have access to the manual developed in view of the particularities of each laboratory, identifying the types of risks to which they are exposed, and the procedures on how to get around them in case of an emergency.

Users of teaching / research laboratories in the health area of a renowned university in the south of Santa Catarina, are exposed to the most varied types of risks, being biological, chemical and physical among others, according to MASTROENI (2006, p.4) these risks are characterized by their condition in offering a high potential to cause damage to the worker, product and environment, and are still considered the oldest occupational risk that has been registered. We can characterize these risks as follows: biological risks have their origin through living beings, such as: animals, plants, viruses, bacteria, fungi and protozoa; chemical risks are obtained through the air, through dust, gases, vapors; physical risks are associated with the use of machines / equipment and conditions related to the work environment, which may be: extreme temperatures, noise, vibrations, among others.

Applying biosafety techniques while performing routine work in the health field is essential, as it aims to ensure the health and safety of all users of the laboratories. According to OPPERMANN & PIRES (2003, p.9) when performing outpatient / laboratory activities, one comes into contact with biological agents, such as: blood, saliva, urine, feces, among others, all of them potentially pathological, for not knowing whether the biological material is contaminated, any material of biological origin is contaminated, and never manipulates it without the EPCs, suitable PPE.

Proper use of EPC and PPE is the best way to prevent and protect against accidents at work, according to NETO (2015, p.238) the smart preventive is focused on EPC, as it seeks to reduce collective risks, and they tend to be more efficient because they do not depend on the employee's willingness to use it.

The purpose of this article was to verify that employees are properly prepared to carry out their activities safely, to understand how the university behaves in relation to work safety in order to apply improvements.

The university has a complete structure in laboratories, for teaching and research in the health area. It has excellent quality courses in medicine, biomedicine, dentistry, nursing, pharmacy, physiotherapy and others. To carry out teaching in these courses, practical activities in laboratories are necessary. All laboratories offer some type of risk, depending on the activity developed, however, those that require practices with greater attention to health and safety are: operating technique, human anatomy, pathology, microbiology, parasitology, microscopy, skills.

2. Methodology

The methodology used was the application of a checklist, composed of 42 objective questions, related to health and safety at work in the activities developed by its users in all 32 laboratories of the institution, aimed at teaching and research in the health area. The questions were answered by those responsible for each laboratory, usually laboratory technicians, other times professor researchers at the institution, during a visit to each laboratory unit. With the collected data, the 5 most relevant items were selected to analyze the practice of health and safety at work. Before the questionnaire, the following items were observed: risk map, emergency plan - the escape route, supply of PPE's, handling of garbage, training of the laboratory cleaning staff. Through the answers obtained, statistical data were generated through the Microsoft® Excel® program, so that it graphically presented the work safety behaviors in this sector.

3. Results Analysis

The risk map is a preventive measure that collaborates with protection of workers, it graphically informs all the risks present in the environment in a qualitative way, through colors and circles of different sizes allocated in the plant of the evaluated place, being very objective. This mapping is a very important tool for accident prevention, however, attention must be paid, because with each new equipment, change in the environment, different chemical, it must be updated to maintain its efficiency. The risk map must be attached in a location that is easy to see for everyone who visits the environment. According to the data collected, the results showed that 65% of laboratory units present the risk map.

The preparation of an emergency plan, informing the safest escape route for a possible evacuation from an environment involves many steps, a previous study of the facilities is carried out, where several factors are checked and the necessary adjustments are requested, such as: lighting emergency, informational alarms, number of employees, fire hydrants / extinguishers, study of the floor plan, determination of a PE (meeting point) among many other items, everything must be working perfectly so that in an emergency the situation is circumvented in the most satisfactory as possible. An interesting question, the university trains its employees every six months to fight fires, currently 10% of its 1400 employees are brigadiers, the intention is that this number will continue to increase. The university underwent a recent update of its emergency plan and now has 100% of its laboratory facilities reporting the escape route.

The supply of PPE's is a very important issue when it comes to laboratory activities, however, more important than providing personal protective equipment is to ensure that employees use it correctly.
According to the questionnaire applied, 100% of the interviewees guaranteed to have access to the necessary PPE's whenever they need to, and said they use it correctly, claiming to know the importance of being considered primary containment barriers, due to the courses they take frequently. They use gloves, glasses, lab coats, shoes, among others. According to MASTROENI (2006, p3), those who work with the handling of infectious agents, must undergo constant training and recycling of techniques in the area. Employees pass annually, or when there is a demand for training / refresher courses organized by the coordination of health laboratories.

The laboratories' waste is separated into three types: Biological / infectious waste, where disposable gloves are discarded, paper / cotton used in procedures, material with microorganisms, material for clinical analysis, remembering that syringes with needles have a specific box for disposal. Ordinary garbage and recyclable garbage. All infectious waste is collected by personnel prepared for the activity, and disposed of correctly. The 6% of the laboratories that did not apply in terms of waste disposal, are laboratories where there is no risk, such as a health informatics laboratory and a laboratory with synthetic human parts, among others.

The employees who perform the cleaning of the laboratories also undergo periodic training / recycling, and are instructed not to manipulate any type of substance of biological origin, with their activities very well defined, who handle and clean the benches are the technicians themselves. laboratories. The 2% that did not apply to this item, are laboratories where there is no risk, such as a health informatics laboratory and a laboratory with synthetic human parts, among others.

4. Conclusion

According to the data collected and evaluated, we concluded that the university is very concerned with the health and safety of its employees and users of its facilities, always looking for improvements. This article aimed to find points where they can be improved. We found some items along the 42 applied questions, which deserve attention, such as the case of only 65% of the laboratories having a risk map. Another interesting issue that was raised, the laboratories do not have a personalized biosafety manual for each unit, which should be available to all users. With an unsatisfactory percentage in the risk map and the absence of an individualized biosafety manual, safety in the laboratories is more vulnerable, we know that

these two have precious information about each particular location, as these are personalized studies that seek to reduce risks and point out solutions to emergencies.

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CORPORATE EDUCATION: DRIVING ASPECTS TOWARDS NETWORKED CORPORATE UNIVERSITY

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Abstract

This article aims to analyze the maturity evolution process of the stages of the corporate education system, listing the driving aspects of this process. To accomplish it, a qualitative research with a descriptive exploratory approach was carried out through an integrative review. The survey and systematic review were based on the analysis of existing scientific knowledge about "corporate education" and "evolution of the corporate education system". In the end, it is possible to list 25 driving factors for the evolution of the corporate education system to be considered by organizations that intend to reach the last stage of evolution, the Networked Corporate University (NCU), the most contemporary model proposed by the literature. In conclusion, this study brings theoretical contributions advancing on the existing theories and practices, as it can be considered that, when the Corporate Education System evolves towards the NCU stage, it will meet the context requirement that drives it to amplify the vision, beyond human capital, to social and relational capital.

Keywords: Corporate Education System, Evolution Stage of the Corporate Education System, Corporate University, Networked Corporate University, Driving Aspects.

1. Introduction

The contemporary society characterized by hyperconnectivity and globalization unleashes a world without borders (OHMAE, 1991), which requires organizations' attention to the capacitation, training, and continuous development of their employees.

In this sense, the Corporate Education System (CES) is encouraged to expand its vision beyond the organization's human capital, moving on to its social and relational capital.

This movement leads to the creation, treatment, integration, transfer, protection, and exploitation of knowledge assets (TEECE, 2000), enhancing different actions for the professional and organizational development.

Faced with this context, the development of individual and group skills is implied through training initiatives focused on operationality, other strategies aligned with business strategies, and other that consider not only the internal public, but also customers, suppliers, and others actors that integrate the ecosystem in which the organization is inserted, reaching the most contemporary model of Networked Corporate University (NCU), a study detailed by Freire, Silva, and Bresolin (2019).

The study of the maturity stages of the developed CES motivates the researcher to be interested in investigating how the evolution of these stages takes place. When reading articles with the characterization of NCU stages, guidelines, evaluation models, including the Kraemer questionnaire (2018), definitions are obtained regarding each stage, but not specifically the process of its evolution.

In other words, Kraemer's work is limited to analyzing the evolution stages based on the definitions proposed by the literature for each stage and, thus, it incites the research question of this article: how does the evolution of the stages of CES occur?

Faced with such questioning, this article aims to analyze the maturity evolution process of the CES stages, listing the driving aspects of this process, from the perspectives of authors identified in the literature review.

1.1 The stages of the Corporate Education System

The educational actions and strategies that constitute areas and units in the organizational context are variously denominated, including as CES, as emphasized by Hourneaux *et al.* (2008).

In this sense, in view of the changes and adaptations required in the face of the market and technology, organizations demand adjustments and complementarities in their processes aimed at training, development, corporate education and universities, leading to a progressive change in the maturity stages of corporate education systems.

In this evolutionary process, among the studies surveyed, the most contemporary model was identified, the Networked Corporate University, elaborated and established by the authors Freire *et al*. (2016a). This work points out six stages of corporate education: Training Department, E-learning Platform, Corporate Education, Corporate University, Stakeholder University, and NCU.

The stages proposed by the NCU model, which, according to the authors, are complementary and the basis for the development of the others, are presented below.

The stage called Training Department (TD) focuses on training focused exclusively on the quality and effectiveness of the tasks developed by the organization's internal public. Attention is focused on human capital and there is no alignment between the organization's strategic objectives and learning, without reflecting on processes or goals to be achieved. The use of educational technology is not significant, with low reach and interconnection of those involved in educational processes (FREIRE et al, 2019). These characteristics dialogue with Goldstein (1980, p. 230), when conceptualizing training as “acquiring knowledge, skills or attitudes that result in better performance in an environment in the workplace”.

The E-learning platform (EL) is characterized as the second stage of CES by the adoption of technologies that allow educational actions to be reached wherever students are, expanding the face-to-face structures to virtual education environments. In this sense, there is greater interconnection offered to the organization's internal public, which remains the focus of education services and with development focused on the task. It is perceived that it starts to provide more comprehensive opportunities for the development of competencies necessary to the specificities of organizations, optimizing time and space, as well as economy when implementing platforms for training large teams (SILVA, 2019).

Corporate Education (CE), as the third stage, integrates strategic alignment to corporate education services. The model emerges in the 1990s "as an alternative to increase individual training and, consequently, generate higher levels of competence for organizations" (HOURNEAUX *et al*., 2008, p. 106). In this sense,

the focus of the previous stages that covers the internal public, the use of education technologies, and the human development for tasks are aligned to the strategic objectives of the organization. In this orientation of perspective, the educational services pass from the employee to the development of the learning capacity of the organization (SILVA; SARSUR; VASCONCELOS, 2016).

The fourth stage, called Corporate University (CU), presents an advance in relation to the previous stages, since, in addition to the internal audience, it integrates other participants of the value chain in the development of educational actions. Freire *et al.* (2019) highlights the expansion of the scope of educational actions, the strategic alignment of business and learning, turning to development in management and strategic education and not just the task. The intensified use of information and communication technologies (ICTs) drives greater interconnection among those involved. In this sense, corporate culture for continuous learning becomes a purpose at this stage. The CU proposed by Meister (1999) is defined as a strategic "umbrella" for the development and education of employees, customers, and suppliers, in adherence with the organization's business strategies.

The fifth stage, Stakeholder University (SU), extends to all stakeholders the development of strategic competencies, as detailed by Margherita and Secundo (2011). According to Freire *et al.* (2019) the scope is elevated as learning in network is in line with a rich interconnection between the various stakeholders, enabling denser relationships with the use of technology that drive knowledge creation. The established relationships are characterized by long term, encompassing academic universities, seeking to integrate research in the path of co-creation of knowledge assets and value creation for the various actors (MARGHERITA; SECUNDO, 2011). In this perspective, the development of skills and knowledge management favor the institutionalization of the learning culture, focusing on the development of human and social capital.

The sixth stage, the Networked Corporate University (NCU), stands out for strategic alignment among all stakeholders, promoting individual and collective learning (FREIRE et al, 2019). This stage has a high scope for being broad in its relationship with stakeholders and in a fluid way, compared to the previous one, SU, which is characterized by fixed actors and long-term relationship. In this perspective, the development of human and social capital enhances relational capital, as it is based on the relationships between individuals, groups, and organizations (FREIRE *et al*., 2019). In order for the learning process of all those involved in the organizational ecosystem, the importance of Knowledge Management tools is identified for educational technologies and networked development to occur, institutionalizing a networked learning culture: individuals, groups, organizations, and society (SILVA and FREIRE, 2017).

From the presentation of the CES stages, it can be seen that they make it possible to pay attention to and develop the organizational capabilities to keep up with the changes and needs presented by the hyperconnectivity and globalization of contemporary society.

2. Methodological Procedures

To achieve the objective of this study – to analyze the process of evolution of the maturity of the stages of the CES –, this research was conducted in a descriptive exploratory manner, by means of an integrative review.

The methodological approach is characterized as qualitative, with a descriptive analysis of the objectives and purposes of the publications surveyed.

Thus, the review was based on the analysis of the existing scientific knowledge on "Corporate Education" and "Evolution of the Corporate Education System". To this end, the study went through the definition of the themes, and preparation of the research question "*How does the evolution of the stages of the corporate education system occur?*" through data filtering, analysis of the studies included, and discussion of the results. When defining the objectives and research question, the terms in English were identified: "*corporat* educat**" and "*evolution*" for the search in the database, defining strategies regarding the field of search, filtering, and previous results.

. The search field chosen was the Scopus database, as it is the largest database with summaries and citations of scientific articles (FALAGAS; PITSOUNI; MALIETZIS; PAPPAS, 2008). To this end, on September 8, 2020, the key concept - *corporat* educat** was initially used, with *title – abs – key* as search strategies, which resulted in 264 articles. Among these documents, the key concept – *evolution* – was included for search, resulting in 17 articles, without filtering by temporality and type of documents.

Of the 17 articles identified, were excluded those that dealt exclusively with academic education and professional training of academic universities for market requirements; educational policies; evolution of specific areas of knowledge (biology and medicine), resulting in 7 articles for the composition of the study.

As for inclusion, a search directed to the subject evolution of the stages of the CES was carried out in the repository of the Federal University of Santa Catarina (UFSC) library, which led to the identification of Kramer's thesis (2018) and Silva's dissertation (2019), already included in the theoretical foundation. However, these studies were not included in the integrative review, because the authors propose how CES evolves facing the application of the NCU model, not adding the analysis of the evolution of these stages.

In addition to the selected documents, the book *Universidade Corporativa em Rede: diretrizes iniciais do modelo* [*Networked Corporate University: initial guidelines of the model*] (FREIRE; SILVA; BRESOLIN, 2019) was considered, for being a work that presents a rationale for the stages of the corporate education system, including the most contemporary model researched, the NCU.

3. Aspects driving the evolution of the CES stages: identification and analysis

The description of each stage presented above demonstrates the close relationship with the cultural, behavioral, and infrastructure aspects of the organization and the context in which it is inserted.

The identification of other authors' studies made possible by the integrative review highlights the understandings about CES, as well as the sensitive points of attention to be paid, demonstrating drivers in the maintenance and advancement of the stages.

The evolution of the stages according to the NCU model goes through guidelines that cover: the scope of public to be involved; the interconnection between the participants, by means of collaborative technologies; the interested parties, which may include human, social, and relational capital; the focus of educational actions as to the operational, tactical, and strategic level; the level of the courses, from free to those recognized by university diplomas; the use of collaborative education technologies; the knowledge

management, considering learning in network, organizational memory, and knowledge storage (FREIRE *et al*., 2019).

Tables 1 to 5 show the authors' perspectives identified by the integrative review, regarding the stages of education in the CES and the aspects that drive their evolution.

Table 1 - Driving Aspects in the Evolution from TD to EL

Training Department (TD) →	E-Learning (EL)
Driving aspects	1. Technology as an opportunity to increase student motivation, reflecting on retention and dropout rates; 2. Relationship between content and job requirements favoring planning and preparation; 3. Encouraging the sharing of experiences between employees, the mastery of skills, and mentoring, avoiding travel expenses and absences for external training; 4. Promotion of multiple spaces to listen to a teacher, enabling different moments of study, different course duration times, and interactivity; 5. Implement specific characteristics of distance education: o make education accessible to the widest public; o encourage continuing education; o overcome geographical limitations with the use of ICTs; o create new administrative or institutional structures that meet the demand for non-traditional education.

Source: Elaborated by the authors.

As highlighted in Table 1, five aspects were identified that drive the evolution from the Training Department stage to the E-learning stage.

Amrou, Semmann and Böhmann (2013) highlight the extent to which traditional approaches lack motivation for students to actively learn, characterized by the limitation of linked information objectives and *just-in-time* support. To this end, the technology aims to provide an opportunity to increase the motivation of students in corporate educational services, reflecting on retention and dropout rates. In this sense, those authors also comment that the transfer of training requires the content to be related to the job requirements, favoring planning and preparation.

In this perspective of training employees in the workplace, Masalimova, Usak, and Shaidulina (2016) present experiences from contexts such as France and Great Britain that value the meeting of established standards and requirements, the sharing of experiences among employees, the mastery of skills and mentoring, avoiding travel expenses and absences for external training, which provides room for e-learning and the development of educational leaders.

Kaplan and Haenlein (2016) integrate this approach, stating that, when going beyond a single space to listen to a teacher, there is the possibility of different moments of study, different times of course duration, in addition to interactivity.

As shown in Table 1, from this perspective of distance learning, the educational issues necessary for the organization are resumed, addressed by Cranch (1987), which include: making education accessible to the widest public; continuing education to keep up with technological evolution throughout the career; overcoming geographical limitations with the use of ICTs; creation of new administrative or institutional structures that meet the demand for non-traditional education.

Next, in Table 2, the 4 driving factors from E-learning to Corporate Education are described.

Table 2 - Driving Aspects in the Evolution from EL to CE

E-Learning (EL)	Corporate Education (CE)
Driving aspects	1. Investment in strategies to visualize the progress of participants regarding the educational objectives in view of the potential for expansion and democratization, requiring the necessary physical and technological infrastructure; 2. Orientation towards face-to-face communication, collaboration, and interaction, combining e-learning methods and traditional approaches to promote better learning effects; 3. Closer alignment to organizational strategies, investing in long-term courses and in the co-responsibility of managers in organizational processes; 4. Identification of types and forms of training more effective to the corporate formation and the organization's strategy.

Source: Elaborated by the authors.

In Table 2, referring to the evolution from the E-learning stage to Corporate Education, four driving aspects were highlighted.

Regarding distance learning with the use of social media, Kaplan and Haenlein (2016) highlight the possibility of unlimited number of participations, implying new skills for the development of careers and the development of pedagogical innovation in face of the interactivity with participants and their personalized learning. Given this context, the investment in strategies to visualize the progress of the participants in relation to the educational objectives, in view of the potential for expansion and democratization, requires the necessary physical and technological infrastructure.

In line with this perspective, Amrou, Semmann, and Böhmann (2013) highlight the need for orientation toward face-to-face communication, collaboration, and interaction, combining e-learning methods and traditional approaches to promote better learning effects. The investment in corporate education services needs to have a return in the day to day business.

To this end, the use of a human resources management system with accessible information regarding the student's profile, basic information, and training already carried out, accurately demonstrate tasks and requirements for the current job and the following possible work levels, as a profile destination, using repository and IT support.

Still regarding investment, Masalimova and Sabirova (2014) identified the targeting of specialist employees who demonstrate more proximity to alignment with organizational strategies, through investment in long-term courses. For the development of skills on scale, it is identified the use of strategies such as mentoring, supervision, manufacturing instructions, and job rotation, favoring knowledge documentation and sharing and, at the same time, the co-responsibility of managers in the corporate education process.

Among the aspects of Table 2, there is also the alignment of corporate education with organizational objectives, in which Masalimova, Usak, and Shaidulina (2016) emphasize socioeconomic and organizational-pedagogical conditions as conditions for the selection of corporate education processes to be developed, which lead to the identification of types and forms of training more effective to the corporate formation and the organization's strategy.

As for the driving aspects from Corporate Education to Corporate University, 7 aspects were identified and are described in Table 3.

Table 3 - Driving Aspects in the Evolution from CE to CU

Corporate Education (CE)	Corporate University (CU)
Driving aspects	1. Team managers start to perceive themselves as actors capable of communicating, collaborating, creating content, and defining milestones for post-training activities; 2. Building a shared vision to achieve strategic objectives, based on the organization's cultural characteristics; 3. Collaboration and communication through tools such as forums and social media, in order to favor the achievement of organizational objectives; 4. Recycling and reconstruction more quickly for new functions, new machinery, and new technologies, seeing them as opportunities for organizational development; 5. Need for training objectives and goals to be linked to the organization's general strategy 6. Boosting the corporate education system by meeting the corporate needs in a timely manner, and the technological and economic well-being; 7. Encouraging partnerships with traditional higher education institutions towards innovative solutions.

Source: Elaborated by the authors.

From the stage of Corporate Education to Corporate University, in Table 3 it is identified the focus on the development of management skills to develop skills that will strengthen the relationship between strategy and operation, as emphasized by Amrou, Semmanne, and Böhmann (2013). According to these authors, team managers begin to perceive themselves as actors capable of communicating, collaborating, creating content, and defining milestones for post-training activities. In this sense, Freire *et al*. (2016a) emphasize the alignment between strategy and operation, through investment in management development, in the training of multipliers in order to build a shared vision to achieve the strategic objectives, based on the cultural characteristics of the organization.

To enable this shared vision, Amrou, Semmann, and Böhmann (2013) emphasize the importance of collaboration and communication through tools such as forums and social media, in order to favor the achievement of organizational objectives.

As a mobilization requirement, Freire *et al*. (2016) identify that the competitive differential in the face of the needs of the market and society requires a quick way of recycling and reconstruction for new functions, new machinery, and new technologies, seeing them as opportunities for organizational development.

Malisamova, Usak, and Shaidulina (2016) also present this perspective of mechanisms and tools for professional qualification, considering assignments and job transfers at national and international levels. To these authors, based on the specifics of the business, the focus is on career development and the return it provides in the conquering of the market. Thus, they emphasize the need for training objectives and goals to be linked to the organization's overall strategy.

In this sense, Cranch (1987) also emphasizes that meeting corporate needs in a timely manner, and the technological and economic well-being boost the corporate education system, leading to meeting the demand for qualifying workers in specific activities with technological advancement and compatible organizational structure; specialized products and processes; language courses; equivalence to university credits, among other aspects.

Following this understanding, in Table 3, it is highlighted the statement by Freire *et al*. (2016 a) regarding educational and development programs being attentive to the business context, the essential skills, and corporate citizenship, which drive partnerships with traditional higher education institutions towards innovative solutions.

During the analysis of the driving aspects from Corporate University to Stakeholder University, 5 aspects were identified and described in Table 4.

Table 4 - Driving Aspects in the Evolution from CU for SU

Corporate University (CU) →	Stakeholder University (SU)
Driving aspects	1. Cooperation and sharing of resources between academic and corporate institutions, exchange with visiting professors, and students invited as professors, generating shared improvement; 2. Pedagogical innovation in the interactivity with participants, and their personalized learning; 3. Interactions between those involved that enhance collaboration and cooperation, generating a significant impact on corporate education processes; 4. Sharing and creating knowledge at the individual, group, and organizational levels, going beyond their borders; 5. Perception of the organization's role in the social, economic, and political dimensions, in a systematic dynamic that can make collective learning possible.

Source: Elaborated by the authors.

In Table 4, evolution from Corporate University to Stakeholder University, according to Cranch (1987) the investment in human resources to increase productivity unfolds in continuing education and corporate classrooms. To this end, continuing education needs to be attentive to educational programs with specific focuses, short courses, use of software, and the exchange between academic and corporate institutions. This hybrid movement implies cooperation and sharing of resources between both sectors, exchange with visiting professors, and students invited as professors, generating shared improvement.

The hybrid movement emphasized by Cranch is complemented by Kaplan and Haenlein's view of the development of synchronous and asynchronous classes, leading to pedagogical innovation in face of the interactivity with participants and their personalized learning. In this sense, the potential for expansion and democratization of education drives the transmission of knowledge, relying on making materials available so that students can use them according to their needs. In the perspective of these authors, the interactions between those involved enhance collaboration and cooperation, generating significant impact on the corporate education process.

This movement of collaboration and cooperation is also highlighted by Freire *et al.* (2016a) emphasizing that the attention given to members of the production chain – employees, customers, suppliers – expands the perception of processes and results beyond the organization to partner organizations and/or parties interested in its results. The need to share and create knowledge at the individual, group and organizational levels, going beyond its borders, is present.

According to these authors, interactivity leads the organization to perceive its role with the social, economic, and political dimensions, in a systematic dynamic that can make collective learning possible.

Finally, Table 5 shows the aspects identified as drivers from Stakeholder University to Networked Corporate University.

Table 5 - Driving aspects from SU to NCU

Stakeholder University →	Networked Corporate University (NCU)
Driving Aspects	1. Need for the organization to include in the learning network all stakeholders of the organizational ecosystem, going beyond customers and suppliers; 2. Curation of this co-creation of knowledge as a collective learning memory, favoring to all participants its use, reuse, review, renewal, and innovation; 3. Support the creation, sharing, structuring, dissemination, and use of knowledge in the organization and in the organizational ecosystem; 4. Need for Knowledge Governance, favoring the socialization of experiences, good practices, and lessons learned as a basis for reuse and innovation

Source: Elaborated by the authors.

Table 5 identifies that, based on the social network experienced, with its norms and bonds of trust, there is the joint incentive of the participants, sharing objectives. In view of this, Freire *et al.* (2016b) state the need for the organization to include in the learning network all the stakeholders of the organizational ecosystem, going beyond customers and suppliers.

To these authors, the connectivity required for the implementation of practices, techniques, and tools in a cooperative and collaborative movement requires a high level of trust. To this end, it is necessary to review cultural, behavioral, and structural aspects of the organization.

As for the collective performance, Freire *et al*. (2016a) highlights the need for the curation of this co-creation of knowledge as a collective learning memory, favoring the use, reuse, review, renewal, and innovation to all participants.

To this end, methods and techniques must be adopted to identify critical knowledge, capturing, representing, and structuring this knowledge. In the same sense, there is the need to apply information and communication technologies for the development of practices and techniques in intra and inter-organizational communication. This gives support to the creation, sharing, structuring, dissemination, and use of knowledge in the organization and in the organizational ecosystem.

As shown in Table 5, according to Freire *et al*. (2016b) this process leads to the characterization of Networked Corporate University as an intelligent environment of continuing education, which manages and institutionalizes a learning culture among all those involved. In synchrony with this movement, there is the need for Knowledge Governance, favoring the socialization of experiences, good practices, and lessons learned as a basis for reuse and innovation.

Thus, in summary, after the integrative review performed, 25 aspects that drive the evolution of the corporate education system can be listed. These aspects should be considered by organizations that intend to reach the most contemporary model, that is, the NCU model.

4. Final considerations

The systematic search of the literature, together with the integrative review of its results, made it possible to list 25 aspects that drive the evolution along the stages of the Corporate Education System. These 25 driving aspects favor the collective journey towards organizational learning, considering the curation of the co-creation of knowledge as organizational memory, as highlighted in the Networked Corporate University stage.

Among the most cited points by the authors studied, are present in the evolution process of the stages: the choice of education technologies (present in the evolution to the E-learning, Corporate Education, and Networked Corporate University stages); the use of information and communication technologies (identified in the evolution to E-learning, Corporate Education, Corporate University, Stakeholder University, and Networked Corporate University stages); the alignment to organizational strategies (appearing in the evolution to the Corporate Education, Corporate University, Stakeholder University, and Networked Corporate University stages); the sharing and co-creation of knowledge, and the expansion of educational actions to audiences in connectivity with the organization (highlighted in the evolution to the Corporate University, Stakeholder University, and Networked Corporate University stages).

In this sense, the understanding of these drivers led to confirming the seven guidelines of the Networked Corporate University (NCU) model, which are: reaching the actors to be involved in the educational actions, the interconnection between these actors, the recognition of the stakeholders, the education technology, the focus on strategic alignment of educational actions and organization, the level of coverage of education programs, and the management of knowledge for the sharing and memory of learning networks (FREIRE; SILVA; BRESOLIN, 2019).

From the analysis on the publications carried out by this research, three guidelines stand out most: the focus on strategic alignment, seeking a shared vision with educational actions (MASALIMOVA; USAK; SHAIDULINA, 2016); the recognition of stakeholders from the internal and external community, understanding needs and expectations to reach educational processes (FREIRE *et al*, 2016b); the interconnection from information and communication technologies, which enable the integration, inclusion, and interactivity of the different authors (KAPLAN; HAENLEIN, 2016). In other words, these three guidelines can be considered as vital to the evolution of the corporate education system to attain the Networked Corporate University stage.

In conclusion, the six stages of evolution of the Corporate Education System, the 25 aspects that drive the evolution between the stages, and the seven guidelines to be managed to achieve and develop the Networked Corporate University are confirmed.

This study brings theoretical contributions, advancing on existing theories and practices, for it can be considered that, when evolving the Corporate Education System towards the Networked Corporate University stage, it will meet the demands of the context that urges it to broaden its look beyond human capital to social and relational capital.

As for further research, the continuity of this study is suggested, especially regarding empirical studies for the analysis of the driving aspects in the field and the evaluation of the viability or not of the aspects present in the organizations and in the ecosystems to which they belong.

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Acquiring Knowledge the Quilombola Territory of the Jambuaçu River through the Games

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Abstract

This game aims to become a didactic-pedagogical tool to facilitate the interaction and transmission of history, culture and some traditional knowledge of quilombola community living in the Quilombola Territory of the Jambuaçu River, located in the municipality of Mojú, state of Pará, to be applied to the students of the local schools and students of the School of Application of the Federal University of Pará. It also aims to boost the interaction between these different worldviews, through the joint elaboration

between quilombola researchers, community members of the Quilombola Territory of the Jambuaçu River and the others researchers.

Keywords: mobile game, education, quilombola, interaction

1. Introduction

Simone Lucena [1] informs that in the last decades of the twentieth century, the insertion of information and communication technologies (ICT) in different social sectors potentiated new forms of communication, learning and the dissemination of digital contents and cultures. She adds that at the beginning of the 21st century, a new technological transformation in the media stands out: the use of portable technologies and mobile networks. The social interactions marked by the use of these new resources led to the development of new sociotenic processes and the birth of new types of languages as a new and dynamic culture of mobility. The United Nations (UN) through the United Nations Educational, Scientific and Cultural Organization (UNESCO) develops activities that seek to preserve heritage and cultural entities, stimulate creativity, oral traditions, reading and book production [2]. And for the sake of information, it seeks to promote freedom of the press, the free circulation of ideas through audiovisual means, independence, pluralism and the diversity of the media through the International Program for the Promotion of Communication with a focus also on preserving human rights, and try to overcome the global digital divide. Thus, it is intended to develop a game for cell phones that aims to disseminate information about quilombola communities to the world. To alternatively teach quilombo children their origins in a playful way to motivate them to learn more about their past and to help endure the history and traditions among young people and adults.

2. Motivation

When observing the history of Brazil, it is noted that the effort of blacks is striking, where they could enjoy the freedom to be and live according to their customs and maintain these groups of resistance to slavery. Historically quilombos have been the ultimate expression of freedom and appreciation of beliefs, traditions, customs. The quilombo was the collective experience of Africans and their descendants in the diaspora in a reaction to slavery, added to the contribution of other segments with which they interacted in each country, notably with some indigenous peoples" [3]. It is well known that the quilombola people do not have the visibility they deserve in different ways, as they are historically imposed the prejudice of being an abject subject [4] where the black person is not considered to be a life subject capable of dignity, education is essential and with that the inequality is alarmed [5]. Quilombola people constantly suffer from discrimination and prejudice due to the society's lack of knowledge about their culture. To help combat discrimination and prejudice, the development of this application arises with the aim of promoting historical knowledge and awareness about the quilombola culture and people that deserve greater prominence, recognition and respect before Brazilian society.

3. Playful Teaching

The global prominence achieved by the advance of the means of distance communication demonstrates an expressive reach together with education, according to UNESCO website in Brazil [7] "the estimated population of the Earth is 7 billion people, among them, 6 billion already have access to a working mobile phone". Given this fact, in 2013, UNESCO launched the "UNESCO Policy Guidelines for Mobile Learning" [6], by which it defines mobile learning as a branch of information and communication technology, connecting people for the creation of educational content, emphasizing the accessibility of education.

Mobile learning therefore appears as one of the solutions to the challenges faced by education, as it popularizes access to knowledge. In cyberspace it is essential to recognize the educational potential of communication tools, which are technologies in the form of digital applications that act as channels for educational dialogues between school, family and society, fostering this as a communication resource in the formation and construction of citizenship.

Electronic games, common in the daily lives of children, adolescents and adults, must be understood as an educational mediation tool that helps in the teaching-learning relationship in interdisciplinary educational processes.

4. Game Modes

Several game modes have been defined to make a more intuitive interface, as seen in Figure 1, for the user to orient themselves within the game. There are tabs through which you can get to know important people better, considered leaders in the quilombola territory, understand a little of the culture from the functioning of the archaeological site and the championship, with mini-games, or learn about the history of the Quilombola Territory of the Jambuaçu River and their communities through a platform game, evaluating the content discovered through quizzes.

Figure 1: Main Menu

4.1 Characters

In the characters mode, it will be possible to know the main leaders and their importance for the historical construction of the researched territory, as in Figure 2.

Figure 2: Main heroes of the quilombola territory of the Jambuaçu river.

For children and young quilombolas who will play, knowing the history of these characters and the formation of the territory where they live is important, in order to preserve this knowledge and pass it on to future generations.

The contribution of this knowledge to non-quilombola students and society in general, makes it possible to present the existence of the Quilombola Territory of the Jambuaçu River, in the municipality of Moju / PA, so that they know the history of struggle and resistance of these people who want to be seen, heard and respected by all, in addition to having their rights assisted by the government.

4.2 Mini-games

Through the mini-games, users will be able to better understand the culture of the quilombolas through two games, one about the functioning of the archaeological site, present in the quilombola community of São Bernadinho / Moju - PA and the other about the quilombola championship. The mini-game menu can be seen in Figure 3.

Figure 3: Screen with mini-games

The game of the archaeological site will aim to find on the screen artifacts obtained in Quilombo. After finding the object, it will be in a register, which the user will have access to at any time to know the history of the chosen piece.

The game about the quilombola championship will focus on football, a sport practiced during the tournament. The games will be aimed at the entertainment of users, which may be against artificial intelligence or against a friend from the local multiplayer. Although the focus of this mini-game is on children's entertainment, it will still have the option to click on a souvenir book, where the winners of the past championships will be registered, with the classification of all games in the competition.

4.3 Story Mode

In the history mode, the user can first enter the map with quilombola communities, which will show the fifteen communities that form the Quilombola Territory present in Pará, as seen in Figure 4.

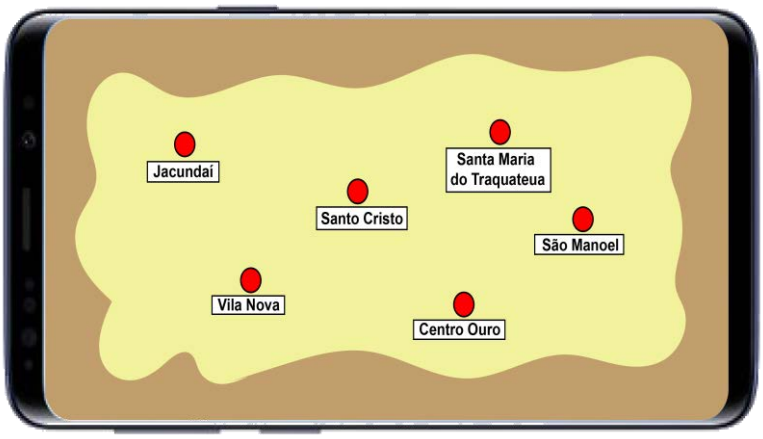

Figure 4: Map with some quilombola communities.

When clicking on one of the communities, the user will be directed to a screen where they will have information on the chosen community, as seen in Figure 5, being explained through text or by a persona. With that, the player will be able to choose between doing a quiz about the community, for academic purposes, or playing within that community.

Figure 5: Menu with the history of a community.

When choosing the "Quiz" mode, the user will be directed to answer ten random questions, in a database about the selected community. As the game will be developed to be used within the academic environment, this mode was developed in order to test the children's knowledge about the community, preferably, being applied after the child reads, hears about or plays within the community.

When clicking on "Let's Play" it will be as if the user is playing within the community. This game mode will be created to be more interactive both with the player and with the history of the quilombola community,

through a gameplay similar to adventure and fighting games. In this mode, the persona of the player will enter the community, at the time of its origin, and live the same adventures that occurred at that time. As for example in the history of Aurestiano of the community of Poacê, where the main character will have to carry out several fights, in addition to organizing and guiding his people in the face of the difficulties faced by the community, such as attacks by external agents, invasions of territory, among others.

As a reward for each mission completed, the user will receive an achievement, to motivate him to continue playing. These achievements will also be related to the contents seen regarding the communities. As an example, when completing the mission mentioned above, the user will receive the "Foundation of the CFR Padre Sérgio Tonetto school" archievement.

5. Conclusion

The application emerged as a learning resource for children and adults, in a playful way it promotes knowledge about the quilombola culture and identity, it seeks to represent quilombola teachings and traditions, presenting the academic community that collaborates with the elaboration of this application. It is important to highlight the approximation that this didactic resource provides in society, promoting cultural diversity and combating discrimination against quilombola culture through education.

The didactic resource is being developed to be used by students and teachers in schools, initially it will be implemented at the UFPA Application School (EA-UFPA) and with children from the Quilombola Territory of Jubuaçu.

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INTELLECTUAL PROPERTY IN THE PERFORMANCE OF PHYSICAL EDUCATION PROFESSIONALS: CHARACTERIZING ELEMENTS FOR COPYRIGHT PROTECTION

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Abstract

In essence, man stands out for the use of your intellect to overcome his challenges and remain in constant evolution. Throughout its history, mankind has developed laws, rules and criteria to protect inventions and innovations. Along the way, a copyright law was created that supports and protects works and products from human intellect. Through it, it is possible to stimulate and leverage diverse sectors and professionals. Based on this, this study aims to characterize the prescriptions of physical activities, therapy, prophylaxis and their relationship with copyright. Its methodology is Grounded Theory, or theory based on data analysis and analysis of the legislation of the professional exercise of Physical Education (CONFEF). As preliminary results, it was identified that there are elements that allow the authorial protection of the training sections, in the prescription of prophylactic and therapeutic activities because they present characteristics of intellectual property and the Physical Education professional, in their functions and attributions, demand innovations and inventions customization of training sections.

Keywords: Intellectual property, Technological Production, Copyright.

Contextualization

Historically, man uses your intellectual capital to solve problems, whether individual or social. Since its emergence, humanity manipulates and develops materials that facilitate and contribute to its progress. Through inventions and innovations it was possible to "control" the fire, create tools, build houses, explore the depths of the oceans and even reach space (Silveira, 2014). The intellectual production is vast and it would hardly be possible to present all the products built and used by man here, nor does it give due credit and values to its authors. It is from this premise that intellectual property arises that can be understood as:

> The WIPO Convention defines as Intellectual Property, the sum of the rights relating to literary, artistic and scientific works, to the interpretations of the performers and to the performances of the performing artists, to phonograms and broadcasting broadcasts, to inventions in all fields of activity human rights,

> scientific discoveries, industrial designs and models, industrial, commercial and service brands, as well as commercial firms and trade names, protection against unfair competition and all other rights inherent to intellectual activity in the industrial, scientific domains , literary and artistic (Barbosa, 2003, p. 10).

It is through the laws present in intellectual property that it is possible to protect and make those who invent or innovate have their rights met. Within this system of norms is industrial property and in Brazil, in 1996, Law 9.279 / 96 was passed, which regulates and credits the inventions and innovations produced by the human intellect. Therefore, artistic works, architectural projects, industrial designs, utility models, are some of the constructs that can be protected (Speziali; Galdino, 2019).

In the present study, the copyright law stands out, which by means of Law No. 9,610 / 98, protects and safeguards the rights prior to the creation of prints, architectural, scientific, artistic, literary projects, among others; and just as it is possible to protect an architectural project, the protection of a training section is advocated here.

Still, Law 9,610 / 98 defends that the author has his rights over his creation, whose author is the one who creates the intellectual work and develops it. For this protection, registration and art. 18 of Law No. 9,610 / 98 establishes that the author must identify that he is going to request protection from the National Library or National Institute of Intellectual Property and asks for protection.

In the scope of copyright, there is a clear intention of intellectual protection and valuing the inventor or creator, and it is through this intentionality that the Physical Education professional stands out. It is understood that, during a training period, the Physical Education professional demands intellectual capital, as he needs each client to personalize and elaborate training sessions specific to the needs of each practitioner. Thus, each physical evaluation requires the need to change the training sector, leaving the professional with a new demand for the planning and construction of the sector.

Scientific Problem

It is within this specificity that we seek to answer the following question: do the prescriptions for physical activities, whether prophylactic or therapeutic, have characteristics of the work provided for in the legislation that protects the author's rights?

Objective

To characterize the prescriptions of physical activities, therapy, prophylaxis and their relationship with copyright.

Methodology

To search for information, Grounded Theory, or theory based on data analysis, was applied. Initially, it was necessary to carry out an analysis of the legislation of the professional exercise of Physical Education (CONFEF). At this point, the laws and resolutions that presented the characteristics of the performance of

the professional in Physical Education were sought. It was also necessary to carry out a search in the literature.

It was used the recurse of broader literature at https://scholar.google.com/schhp?hl=en-US to identify understandings about prophylactic activity and therapists in physical activity and training methods. Primarily, the following keywords were used: 'Training method', 'prophylactics', 'therapies' and 'physical activity'. Then, the grouping of information, according to the relations on characteristics and conceptual description of the training methods, characterization of prophylactic and therapeutic activities.

Copyright

Imagine the following situation: some one spend days, months, or even years planning, structuring, building, studying and producing something that has an impact and tangible or intangible value, such as a play, article, book, film, music, melody, expressions artistic, plastic arts, architectural design, scientific article, for example. After countless hours searching for an identity to their product and making it tangible, someone simply decides to reproduce their object that demanded so much intellectual and even material investment, worse than that, these people are able to profit, to have advantages over their work. What would be reaction? What if that person wasn't punished? Or if there were no means to establish protection for your invention or innovation? How did you feel about creating new products? Through this perspective, the relevance of copyright is feasible, not only as protection, but seen as an incentive for the growth of intellectual capital in several segments and, mainly, significant and necessary for the continuity of intellectual production. Therefore, during this study, we will seek to discuss how copyright can be used in the performance of the Physical Education professional, mainly on the demand for planning and structuring the training sections.

Copyright in Brazil is based on Law 9,610 / 98, of February 19, 1998, this law defines the author as:

> […] being a natural person who creates a literary, artistic or scientific work, portraying the very personal character provided by the Constitution, through articles 11, 22, 24, 27, 28, 29 and 30. According to the law, the author and the work are closely linked , therefore, the holder's right is exclusively associated with his person (WINDSOR, 2020, p. 28).

In article VII, we have the definition and characterization of the passive protection elements in the copyright law. Specifically, in item X, there is talk about the protection of projects, sketches and plastic works while subject to protection. Therefore, when a Physical Education professional develops a training program or periodization, whether for prophylactic or therapeutic purposes, it is understood and defended here the insertion of protection through law 9.610 / 98.

It becomes cliché to state, in the 21st century, that systematic and regular physical activity presents significant data in its practitioners when it comes to prevention and maintenance of health status. The regular practice of physical activity, in addition to causing changes in the health status of practitioners, has been defended in numerous studies as fundamental for an improvement in the framework of public health

in general. Discussing the benefits of physical activity is not the intention of this study, there are many studies proving such data, the purpose here is to think about the valorization of professionals who plan, elaborate and systematize the training sections and programs, defend and reflect on the need for protection of this intellectual good.

The regular practice of physical activity has been defended and vehemently proven as an effective means of preventing and maintaining the practitioner's health status. It is possible to associate this phenomenon with countless benefits in different segments, such as: anthropometric, metabolic, cognitive and psychosocial effects, falls, risk of injury and therapy, in addition to being associated with quality in mental health today (Matsudo, 2009). However, it should be noted that the absence of periodization or a well-defined and specifically designed section, too, can be associated with risks, injuries and even death (Pinheiro, et all, 2017). Further justifying the need for and valuing the presence of Physical Education professionals in the public health sector.

When we think about physical activity, we inevitably condition it to prophylaxis, as studies such as Santos et al, (2020), Barbosa, (2020), Mileo & Carvalho, (2020), Tozo, (2020), Campos, (2020) by Carvalho et al (2020), present relevant and significant data regarding the regular practice of physical activity, systematizes its impacts in the prevention of numerous diseases and population groups such as the elderly, pregnant women, special groups, obese people, heart disease and cancer prevention.

In the sphere of therapeutic physical activity, we can think of actions related to the treatment of mental illnesses and disorders, such as depression, isolation and mental disorder, aiming at the rehabilitation of health status (Lourenço et al, 2017). This activity model has been presenting significant data on the readaptation and conditioning of patients with conditions related to depression, points out Mendes, et al, (2020). Therefore, it is possible to substantiate and support the theory of relevance and meaning of the Physical Education professional in health and society.

Physical activity prescription

Knowing which model to follow, methods to use, structuring the load, volume, intensity, schedule, identifying the variations, perceiving the changes provided by the activities and exercises, are some of the attributions in the process of systematizing the training and prescription of physical activity of a professional in Physical Education (Dantas et al, 2011). Thinking and systematizing all paths towards the practitioner's goals is an intellectual task and requires conceptual and specific domains when setting up the entire process (figure 1). Therefore, the following reflection would fit here: Do Physical Education professionals carry out intellectual actions inherent to copyright protection? Could its function be based on the thinking of prescription?

Figure 1 - Types of models used in physical training.

Author	Model	Characteristics	Goal
Matveev	Classic / Traditional Model	General adaptation syndrome, undulating load variation,	Physical preparation, improvement of technical skills, VO^2,

		preparation period, competition period and transition period.	peak and performance.
Verkhoshanski	Block Model (Concentrated Loads)	Programming, organization, control.	Load individualities, load concentration, capacity developments and specific work.
Gomes	Selective Load Model	Double periodization lasting 26 weeks for each macrocycle and improvement of speed capabilities.	The improvement of movement speed.
Bondarchuk	Integrating model	Development, maintenance and rest .	Performance and performance.

Source: (Dantas, *et al*, 2017)

Regulation of the Physical Education professional

Through organic law no. 8080/90 physical activity is seen as a determining and conditioning factor of health. With this achievement, the physical education professional starts to occupy and conquer other spaces of performance (Lotti; Nakamura, 2020). Today, there are Physical Education professionals in various health segments such as Family Health Support Center (Nasf), Psychosocial Care Centers (Caps), primary health care, secondary care and tertiary care (Júnior, et al, 2017). In addition to spaces in the sports, educational, leisure and recreation spheres, among others. Therefore, with the occupation of new spaces, new competences and skills emerge. Therefore, greater demand for applied knowledge.

Figure 2 shows three laws that specify the variations of knowledge inherent to the professional practice in Physical Education. In it we have attributions aimed at promotion, protection, recovery, organization, prevention, rehabilitation through physical activity for health. Thus, the relevance of the Physical Education professional is factual, whether in prophylactic or therapeutic actions.

Figure 2- Role of the professional in Physical Education

Law nº 8080/1990	Provides for health actions aimed at health promotion, protection and recovery, the organization and functioning of the corresponding services.
Law nº 9696/1998	The area of physical activity and health serves the purposes of health promotion, prevention, protection and rehabilitation, through physical exercise and physical activity, constituting the intervention area of the Physical Education Professional and submitting to technical and ethical control professional.

Law nº 12864	Changes the caput of art. 3 of Law 8,080, including physical activity as a determining and conditioning factor of health.

Source: (CONFEF, 2021).

The laws presented in table 1 bring in its core that the Physical Education professional have to evaluate, collect data, apply and interpret laboratory tests, physical evaluation protocols, to know, plan, apply psychomotor methods and prescribe according to the client / patient specificity and need. Due to these variations in their function, the need for intellectual application for the construction and prescription of the activity is highlighted, since, in this way, the professional involved must customize and elaborate the training section according to the clinical requirement or objective of the practice. It is in this perspective that the possibility of copyright protection exists, taking into account that there is, in this element, the use of intellectual property.

Figure 3 shows the resolutions that foster and highlight the attributions and conceptual and technical competences of the physical education professional, here you can see the legal fields of action. The professional can perform his / her role in hospital contexts and provides other measures, water aerobics, cardiovascular area, psychomotricity, water sports, physical evaluation, sports / physical training, sports gymnastics, labor gymnastics, Exercise biomechanics and other measures, resistance training and weight training. Physiology of Exercise and Sport, family health, mental health, collective health, *pilates* and acupuncture. It is perceived that it is a vast area and with a high degree of knowledge, highlighting the importance of institutions in structuring and promoting the practice of this professional (FIGUEIREDO, et al, 2020).

However, the focus here is to draw attention to the intellectual employment required for each practice of this. It is undeniable the variability of each activity, the objectives of clients or students, all of these elements culminate in the development of new sections and more intellectuality. Perhaps there is a need to rethink the valorization of the Physical Education professional, and to focus on intellectual property.

Figure 3 - Areas of activity of the professional in Physical Education

RESOLUTION	POWERS AND COMPETENCES
CONFEF nº 391/2020	Recognition and definition of the performance and skills of the Physical Education Professional in hospital contexts and other measures.
CONFEF nº 387/2020	Provides for Professional Specialty in Physical Education in the area of Water Aerobics.
CONFEF nº 386/2020	Provides for Professional Specialty in Physical Education in the Cardiovascular area.
CONFEF nº 375/2018	Provides for Professional Specialty in Physical Education in the area of Psychomotricity.
CONFEF nº 342/2017	Provides for the Professional specialty in Physical Education in Water Sports.

CONFEF nº 328/2016	Provides for Professional Specialty in Physical Education in the area of Physical Assessment.
CONFEF nº 327/16	Provides for Professional Specialty in Physical Education in the area of Sports / Physical Training.
CONFEF nº 326/16	Provides for Professional Specialty in Physical Education in the area of Sport.
CONFEF nº 324/16	Provides for Professional Specialty in Physical Education in the area of Sports Gymnastics.
CONFEF nº 323/16	Provides for Professional Specialty in Physical Education in the area of Labor Gymnastics
CONFEF nº 322/16	Provides for Professional Specialty in Physical Education in the area of Exercise Biomechanics and provides other measures.
CONFEF nº 312/15	Provides for Professional Specialty in Physical Education in the area of Resistance Training / Bodybuilding
CONFEF nº 262/13	Provides for Professional Specialty in Physical Education in the area of Physiology of Exercise and Sport.
CONFEF nº 255/13	Provides for Professional Specialties in Physical Education
CONFEF nº 232/12	Provides for Professional Specialty in School Physical Education
CONFEF nº 231/12	Provides re Professional Specialty in Physical Education in the Family Health Area
CONFEF nº 230/12	Provides for Professional Specialty in Physical Education in the area of Mental Health
CONFEF nº 229/12	Provides for Professional Specialty in Physical Education in the area of Public Health
CONFEF nº 201/10	Provides for Pilates as a modality and method of gymnastics and provides other measures
CONFEF nº 069/03	Provides for the use of acupuncture technique by the Physical Education Professional, when his intervention
CONFEF nº 046/02	Provides for the Intervention of the Physical Education Professional and respective competences and defines their fields of professional performance

Source: (CONFEF, 2021).

It is the responsibility of the Physical Education Professional to understand physiological functioning and functional conditioning; conditioning and physical performance; mental well-being and health; provide consulting, advisory and auditing services in its professional specialty; develop research, scientific and technological research in its specialty; and prepare technical manuals and guidance standards in their professional specialty (...) prepare technical manuals, reports and guidance standards in their

professional specialty, develop research, scientific and technological research in their specialty; (deliberation, CONFEF, May 8, 2020).

Based on the functions and attributions mentioned above, the relationship between the performance of the Physical Education professional, intellectual property and author's rights is noticeable. For, Law No. 9,610 / 98, in its description, shows that works produced by the intellect, created and / or invented, are subject to protection. Still in art. 7th item XI, we have that other works that in their configuration, organization or creation come from intellectual property.

Therefore, there are elements that configure and enable the authorial protection of training sections, whether prophylactic or therapeutic. When creating a training cycle or prescription, the Physical Education professional demands intellectual capital, needing to customize the entire prescription according to the needs and objectives of the applicant.

Conclusion

The Physical Education professional is inserted in several social segments. Its attributions permeate aspects of health, training, leisure, recreation, sports and school, and may vary in therapeutic or prophylactic elements. In its regulation there is a need to develop some technical, conceptual, procedural and attitudinal skills and abilities. The professional in this area needs to elaborate, create, develop, prescribe and guide body actions for different purposes and objectives, demanding from him intellectual property.

In the copyright law there are elements that make it possible to protect the training sections, since, in the systematization and elaboration of the training section, the Physical Education professional needs to create, elaborate and develop motor actions directed to the specifics of the client / student / athlete / patient.

The data presented here are preliminary, being the initial path of a thesis that aims to substantiate and enable authorial protection against the performance of Physical Education professionals, impacting their professional practice, seeking to enhance the intellectual property employed in the customization of training sections, prophylactic and therapeutic aspects.

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The Effects of The Tanzanian Railway Network in the Performance of the Rail Freight Operations. A Case of Dar es Salaam to Isaka

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Abstract

The railway is the fundamental means of transport, especially for freight. It has a substantial contribution to the sustainable economy of the country and the region at large. However, some factors have been affecting the performance of rail operations; especially for freight, to the extent of reducing the modal share from rail to roads. This has been resulting in high road maintenance costs and underutilization of the available capacity in the railway. This research has studied the factors affecting the Tanzanian railway network in the performance of rail freight operations. The focus was on the corridor from Dar es Salaam to Isaka because it serves most of the landlocked countries such as Uganda, Burundi, Rwanda, and Eastern DRC. The study used the Performance Measurement theory with the Balanced Scorecard model. Data analysis was done by the Linear Regression statistical method with the aid of SPSS version 20. The results of the study show that derailments, washouts, and rail freight wagons maintenance capacity directly affect the performance of rail freight operations. TRC, therefore, needs to strategize measures for ensuring that derailments and washouts are very much reduced. A plan for quick recovery must be in place in case a derailment or washout happens. Also, TRC should enhance its capacity for maintaining the rail freight wagons to ensure its optimal availability. Railway should be viewed as a potential area for investment because it supports the growth of other sectors as well. If constraints are minimized in the railway system; the performance of rail freight operation will be high and many customers will be attracted to use the railway as a preferred mode of transport, hence, the modal share to the railway will increase.

Keywords: Railway, Transport, Performance, Rail Freight;

1.0 Introduction

Tanzania has four main railway corridors for transport. One corridor is on the northern part and it starts

from Tanga port and the second one is on the southern part starting from Mtwara port. Chelsea Markowitz, 2017 stated that these two corridors mostly transport local people and goods. The two other major corridors are the central and the Dar es Salaam corridors which extend from Dar es Salaam port to various parts of the countries; and therefore, greatly facilitate trade operations in the country (Chelsea Markowitz, 2017).

The central corridor links the Dar es Salaam port to Uganda, Burundi, Rwanda, and the Eastern Democratic Republic of Congo (DRC). Its railway operated by Tanzania Railways Corporation runs from Dar es Salaam to Kigoma and branches to Mwanza through Isaka. This railway is badly in need of maintenance and cannot effectively serve Tanzania's trades or neighboring countries. Therefore, the transportation of goods in the Central Corridor primarily occurs on the road network (Chelsea Markowitz, 2017).

Dar es Salaam host one of the largest hub ports in the East Africa Region that handled a lot of cargos in the region. In 2011 it handled about 1.4 million tons, 13.1 million tons in 2013, and 15 million tons in 2015 (Limi, et.al, 2017). As for Isaka, there is a dry port facility where landlocked countries such as Uganda, Burundi, and the Democratic Republic of Congo can pick their goods by road transport since this dry port is also connected with major roads that go to neighboring countries.

Tanzania Railways Corporation (TRC) was established following the railway's act of October 2017 which also described the objectives and functions of the Corporation (URT, Railway act, 2017). This was the result of the merging of two companies, Reli Assets Holding Company (RAHCO) that was mandated to manage the infrastructure, and Tanzania Railways Limited (TRL) was dealing with railway operations.

According to the Tanzania railway act of 2017, the functions of TRC include the provision of rail transport and manage rail infrastructure, protection of railway reserve, the maintenance of rail infrastructure and rolling stock, acquiring and operate trains as well as repairing anything that belongs to the corporation.

At the beginning of the 20th century, most surface freight was moved by using rail transport. Recently, a small fraction of all freight in most countries is moved by rail. The road has become the preferred mode of transportation for many customers, particularly in developing countries (Aritua, 2019).

Association of American Railroads identified that in 1930, rail freight count was more than 70 percent of the intercity ton-miles, by 1960 the share had fallen to under 45 percent and by 1980 it was under 40 percent. A similar falling trend of the modal share was evident in Europe where the share dropped from 40 percent in 1960 to less than 13 percent in 2000 (Aritua, 2019). A similar modal share falling trend has been experienced in Tanzania Railways where the rail traffic records by TRL suddenly dropped from over 1000 million ton-km to less than 300 million ton-km between 2000 and 2010 and continued to drop further to less than 200 million ton-km in 2013 (Limi, et. al, 2017).

Aritua (2019) states that most railways failed to provide services that meet their customer's needs. Aritua (ibid) further states that this failure has caused many traditional customers to shift to road transport and new customers do not opt for rail transport even for long-distance bulky freight. Limi, et Al. (2017) also state that fewer and fewer shippers are using rail transport because service reliability is deteriorating.

1.1 Problem Statement

Limi et al, (2017) stated that on average road transport in Tanzania costs13.5 US$ per ton-km compare to rail transport which costs4.3 US$ per ton-km. The study done by Limi et al. revealed that road transport cost is nearly 4 times higher than the railway transport cost. But due to the low reliability of rail transport

in the country, many shippers seem not to be attracted to use the rail mode of transport (Limi et.al, 2017). Limi, *et al*. (ibid) stated that the Government spends approximately US$ 310 million on road development and maintenance every year. There is a developed problem of many shippers to use roads as a preferable mode of transportation even though the railway is cheaper as a transportation mode than the road(Aritua, 2019). The result is therefore an increase in road traffic congestions, accidents as well as road damage. It also causes very high traffic on roads and less on the railway.

It was, therefore, important to look at the effects of the Tanzanian railway network in the performance of rail freight operation to find out the challenges which if addressed would lead to a substantial increase in rail freight modal share. Limi, et. al, (2017) explained that globally, the railway carries more percentages of freight demand (9 percent) than passenger demand (6.3 percent). This research has focused on rail freight because of its demand globally in transporting surface freight. For passenger movements, road transportation is the dominant mode in many countries with an exception of some countries such as China, India, Japan, and the Russian Federation where railway transport demand is about 15-30 percent of total passenger transport (Limi, et.al, 2017)

1.2 Main Objective of the Study

The main objective of the study was to assess the effects of the Tanzanian railway network in the performance of rail freight operations.

1.2.1 Specific Objectives

Specifically, the study dealt with the following objectives;

i. To assess the effect of derailments on the performance of rail freight operations.
ii. To assess the effect of washouts on the performance of rail freight operations.
iii. To assess the effect of rail freight wagons maintenance capacity on the performance of rail freight operations.

1.3 Significance of the Study

Tanzanian railway has lost competitiveness against trunk road traffic resulting in having a very low market share. This study contributes toward understanding and identifying more areas that cause railway transport operations, especially for freights, not to perform properly and attract more customers. It was imperative to conduct this study because it can assist the corporation to know potential areas for improving rail freight operations. It should be noted that the railway corporations lose much revenue due to the underperformance of rail freight operations.

On the knowledge gap, the study contributes to the application of the performance measurement theory in measuring the performance of organizations, especially railroad companies. The study is useful to the government on how to prioritize investment in the transportation sector to get more returns and minimize maintenance costs on transport infrastructure (rail and roads). It furthermore helps the projects funding institutions like the World Bank, for example, to understand potential areas of fund allocation to boost the economy of the borrowing countries.

2.0 Literature Review

The key concepts as applied in this study are railway network, performance, rail freight, and operations. A Railway network refers to the system of intersecting rail routes (Collins English dictionary. 1994). These rail routes are composed of a line of parallel metal rails fixed to sleepers and they are used for the transportation of passengers and goods in trains. In this study, the railway network can be explained as the system of intersecting rail routes used for transportation of goods and passengers by using rail vehicles or rolling stock (constructed from the review).

Grüning (2002) defined Performance as the ability of a company to achieve goals, meet expectations, and is therefore influenced by results in a. wider sense, but also by the corresponding goal setting. Wettstein (2002) also said Performance can be understood as the degree of stakeholder satisfaction. Performance can also be referred to as the accomplishment of duty or mission accurately to the satisfaction of the stakeholders (constructed from the review).

Rail freight refers to goods that are transported by trains moving on a railway network(Cambridge international dictionary of English, 1995). These goods are carried by rail freight wagons of different types. This study has adopted this definition because it is relevant as applied in the problem statement. Galloway (1998) defines operations as all activities concerned with the transformation of materials, information, or customers. Operations refer to all activities required to create and deliver a product or service (constructed from the review).

2.1 Theoretical Analysis

This study used performance measurement theory. Performance measurement has the role mainly of assessing the position of the organization and also helping managers to create and implement a better strategy (IonutIvaov, et al, 2013). More than twenty years ago, organizations have invested many resources in the design, implementation, and use of Performance Measurement Systems (PMS) such as the Balanced Scorecard; following a similar principle that measurement is a necessary activity for organizations to be successful. On the contrary, Micheli and Mari (2013) criticized this standpoint and proposes an alternative position according to which measurement should aim to produce 'adequate to purpose' rather than 'true' results.

Federico and Cavenaghi (2017) revealed that there have been no proposals to measure the railroad companies. The study also revealed a lack of comprehensive, strategic, and cause-and-effect Performance Measurement System (PMS). Through their study, they developed the PMS framework for both researchers and practitioners interested in railroad companies' performance measurement. They used PMS based on Balanced Scorecard by considering a case study of a large railroad company in Brazil.

This study tested the application of cause-and-effect PMS based on a Balanced Scorecard (BSC) by considering a case study of a relatively small railroad company, the TRC in Tanzania. The TRC is considered a small railway company because it is operating a railway network with a rail network of 2,722 km; ranked number 60 in the list of countries by rail transport network size. The Brazil network which was studied by Federico and Cavenaghi (2017) is ranked number 6 with a rail network of 38,743 km (Wikipedia contributors, 2020, October 1). Also, this study contributes to the theory in terms of PMS applications.

Performance Measurement System refers to a brief and precise set of measures (financial or non-financial) that supports the decision-making of an organization by collecting, processing, and analyzing qualified data of performance information (Gimbert et al. 2010). This system helps in measuring the performance of organizations so that areas for improvement can be identified. Kaplan (2009; p. 1253) stated that when one can measure what he/she can speak about and express it in numbers, he/she knows something about it; but when he/she cannot measure it, when he/she cannot express it in numbers, his/her knowledge is a meager and unsatisfactory kind. If he/she cannot measure it, he/she cannot improve it.

Fried (2010) stated that Performance Measurement Systems are characterized as strategic expert systems by which organizations observe and measure their intangible performance elements in the form of qualitative and quantitative assessment. Balanced Scorecard (BSC) was developed in 1990 from a workgroup of Nolan Norton Institute, that assisted KPMG in research and establishment of management models (Federico and Cavenaghi, 2017).

Niven (2002) defines a Balanced Scorecard as a careful set of measurements resulting from the strategy of the organization. It is also referred to as a tool that organizations use to manage the implementation of corporate strategies.

Kaplan and Norton (1996) stated that the Balanced Scorecard measures operational performance through four financial perspectives, customers, processes and learning, and growth.

2.2 Empirical Analysis of Relevant Studies in General

Federico and Cavenaghi (2017) studied measuring performance in Rail Freight Transportation Companies – Brazil. The study was done by using the theory of Performance Measurement System (PMS) by Balanced Scorecard (BSC). It was found in the study that the PMS has a very important role in the performance management of railroad companies. The study further showed that the cause and effect of PMSs were not considered by many proposals.

Ahi and Yildiz (2018) studied the performance criteria of the railway market classified a case study of railway companies by analyzing the competitive performance criteria with the innovation capability of the industries using different models. 130 Turkish railway industries were used as the source of data. Methods applied in this study were Porter's Industries Life Cycle Evolution, Diamond, Five Forces Models, and SWOT Analysis. The findings showed that although the applied models have different dimensions, they give the same results. The study concluded that models were consistent and can be used as strategic decision-making tools for improvement of performance. The study did not use PMS to determine the performance criteria of the railway companies.

Sharma et al (2016) benchmarked rail transport service performance for the Indian railway. The study reported that the performance of rail transport services was including the service delivery perspective of railways. The quality of service parameters used were punctuality, level of consequential train accidents (safety), and level of public complaint (customer satisfaction). The method used as a benchmarking tool to evaluate the relative efficiency was Data Envelopment Analysis (DEA). The evaluation was done in 16 zones of Indian railways. The finding in this study was that Indian Railways can use DEA to assess the performance of various zones and in the improvement monitoring as a transportation service provider. The study did not use PMS to assess the performance of rail transport.

Rajeev. et, al., (2016) evaluated the performance of sixteen Indian railway zones to propose a decision-making tool for performance evaluation of Indian railway zones. they suggested the use of a combined multi-criteria decision-making approach that employs the Decision-Making Trial and Evaluation Laboratory (DEMATEL) and Vise Kriterijumska OptimizacijaI Kaompromisno Resenja (VIKOR). The finding was that the application of the integrated methodology could serve as a systematic approach for the measurement of the operational performance of Indian railway zones. The study did not propose PMS as a decision-making tool for performance evaluation.

2.3 Empirical study in African countries

Madubanya (2015) evaluated the operational efficiency of rail freight operations in South Africa. The study aimed at improving the understanding of the value of moving freight on rail than the road. It mainly addressed how the freight rail can manage and improve the operations efficiencies to satisfy the customer's needs by rendering a good service at the same time managing the cost of doing business. The study used the method of Failure Mode and Effect Analysis (FMEA) for analyzing the data. However, this study did not assess the effects of the railway network on the performance of rail freight operations. Lack of continuous performance in railway transportation contributes much to the loss in modal share.

2.4 Empirical studies in Tanzania

Nkya (2015) studied the Role of the Tanzania Central Railway line in Promoting cargo Transportation. The study revealed that the central railway line can transport only 45 percent of cargo compared to its full capacity. This indicates that the central railway line had not fully utilized its capacity in the transportation of cargo. The study identified the challenges facing railway transportation in Tanzania as tear and wear off of the railway line, old engines, and factors associated with railway line width. However, the study did not assess other factors like the frequent interruption of railway operations due to washouts as among the factors which cause the railway transportation in Tanzania not to perform properly and hence resulting in the huge loss of modal share.

Mwakibete (2015) examined the role of rail transport in improving the performance of port as regards Dar es Salaam port. The study used was exploratory and survey techniques to collect data. The study revealed that rail transport plays a great role in port performance for reducing port congestion, improve cargo handling, and increase port and government revenue. Also, rail transport increases the average cargo traffic, improves customer satisfaction, and lowers the logistic cost.

The study further added that, despite the significant contribution of rail transport to the port performance, the situation of the rail was in a poor state. The point was made that more investment has been made on road infrastructure improvement without equal reflection on railway infrastructure. So, the recommendation was for the Government to promote more the railway sector to improve port performance and increase more revenue. It was suggested that in the promotion and improvement, the private sector and other stakeholders must be involved.

2.5 Conceptual Framework

PMS framework developed by Federico and Cavenaghi (2017) for railroad companies by using BSC described four perspectives which are learning and growth, process, customers, and financial. In this study, the dependent variables have been obtained from the performance of rail freight operations. Two of the dependent variables are wagons availability and transit time of trains which are from the operational processes perspective's indicators whereas the other dependent variable, infrastructure maintenance cost is from the financial perspective indicator which is the index of reduction of costs.

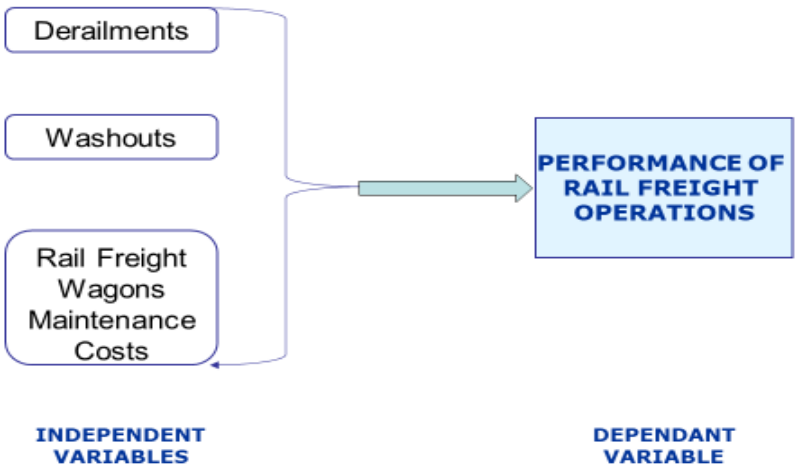

Figure 1.1: Conceptual Framework of the study

Source: Own Creation from Study literature (2020)

2.6 Theoretical Framework

This study used the Performance Measurement theory. The application of this theory can be described by different models. Ionut Ivaov et al. (2013) studied different models used to describe the application of performance measurement which are Balanced Scorecard, Malcolm Baldrige, Performance Prism, and European Foundation for Quality Management (EFQM). This study particularly used the Balanced Scorecard model. This model translates the mission and the organizational strategy into a set of performance indicators that offers a model for the Performance Measurement System (IonutIvaov et al, 2013). IonutIvaov (ibid) further described the model that it assesses the organization's performance through four perspectives which are financial, customer, learning and growth, and internal processes (operational) perspective.

The variables that will be measured in this study are as follows;

Table 2.1: Variables of the Study

S/N	Independent variable	Dependent variable (performance of rail freight operations)
1	Derailments	Transit time
2	Washouts	Infrastructure maintenance cost
3	Rail freight wagons maintenance capacity	Rail freight wagons availability

Source: researcher, (2020)

The table above clearly shows the variables used in this study.

2.6.1. Derailment:

This occurs when a rail vehicle such as a train runs off its rails (Wikipedia contributors. 2020, August 13). It also refers to the loss of contact between the wheel and the rail that may generally be caused by fault on the railway track or rail vehicle (rolling stock) or other causes related to humans.

Railway derailment causes different types of loss and damages to infrastructure, rolling stock, and operations of freight and passenger services. The derailments of rail freight can be severe and consequently may result in different forms of costs that include infrastructure costs, rolling stock costs, interruptions, fatalities, legal and litigations, damage to the third party, environmental costs, damage/delay of cargo, and loss of freight customers (Islam et al 2014).

2.6.2. Transit time:

Transit time is the interval needed for a consignment to be delivered once it has been picked up from the point of departure. it refers to the amount of time spent when moving goods from one point to another (Wikipedia contributors, 2018, April 18).

Federico and Cavenaghi (2017) stated that this variable is measured in hours by using the following formula.

$$\sum_{I=1}^{N}\left(\sum_{i=1}^{n}\frac{\left[\left(Time\ between\ Origin\ and\ Destiny\frac{i}{n}\right)\right]I}{N}\right]$$

Where, N = Days accumulated on month, n = number of trains

The frequency of measuring this variable is Month/Daily

2.6.3. Washouts

These in railroad transport refer to the result of a natural disaster where the railroad bed is eroded by flowing water normally because of the flood (Wikipedia contributors, 2019, August 16). In railways, washouts destroy the embarkment and sometimes bridges and make the rail track unstable. Rainfall records can help to indicate the possibility of washouts in a certain railway section.

2.6.4. Infrastructure maintenance cost:

This refers to the cost that is incurred to ensure that certain infrastructure is kept in good operating condition. In railway, this refers to the cost that a railroad company incurs to ensure that the railway line is in a good and safe condition for operation (Rietveld et.al, 2007).

2.6.5. Rail freight wagons maintenance capacity:

Maintenance capacity refers to the quantitative measure of maintenance capability expressed as direct labor hours that can be applied during a normal workweek (BusinessDictionary.com-Online Business Dictionary, 2016). Rail freight wagons refer to those wagons which are used to transport rail freight from one point to

another. Rail freight wagons maintenance capacity, therefore, is the measure of maintenance capability that is articulated in labor hours.

2.6.6. Rail freight wagons availability:

Wagon availability refers to the state of the wagon being able to be obtained. Federico and Cavenaghi-(2017) identified as an indicator of an operational process perspective that is measured by using the following formula.

$$\sum_{i=1}^{N}\left(Wagon.\frac{h}{Total\ wagons.h}\right)X\frac{100}{N}$$

Where N = Days accumulated in a month.

2.7 Statement of Hypotheses

The hypotheses of the study are therefore formulated as below;

i. *Derailments have a direct impact on the transit time of trains.*
ii. *Washouts have a direct impact on infrastructure maintenance costs.*
iii. *Rail freight wagons maintenance capacity has a direct impact on rail freight wagons availability.*

3.0 Methodology of the Study

Several research strategies can be used in research. These include experiment, survey, case study, action research, grounded theory, ethnography, and archival research (Saunders, et.al 2009). This study has used the strategy of studying a particular objective intensively. The strategy for doing research that involves an empirical investigation for a particular contemporary phenomenon within its real-life context using multiple sources of evidence is referred to as a case study (Robson, 2002). This study has therefore used the case study research strategy because it is based on studying what happens in the real-life context of the railway operations industry.

3.1 Research Approach

This research intends to use the existing theory as an approach to measure the performance of the railroad company. The approach that researchers typically associate with the scientific investigation by studying what others have done, reads existing theories of whatever phenomenon, and then tests hypotheses that emerge from those theories is called a deductive approach (Kothari, C. 2004). This study has therefore used the deductive approach. The advantage of using the deductive approach is that the researcher can use the available theory and he/she is independent of what is being researched. The limitation of this research approach is that the researcher cannot develop a theory from this type of study.

3.2 Research Design and timeline

A research design is the procedures for collecting, analyzing, interpreting, and reporting data in research studies' (Boru, 2018). As explained by Robson (2002), there are three possible forms of research design:

exploratory, descriptive, and explanatory. His base of classification relies on the purpose of the research area as each design serves a different end purpose. For instance, the purpose of a descriptive study is to provide a picture of a situation, person, or event or show how things are related to each other and as it naturally occurs (Boru, 2018).

Explanatory research looks for causes and reasons and provides evidence to support or refute an explanation or prediction. It is conducted to discover and report some relationships among different aspects of the phenomenon under study (Boru, 2018).

Saunders, et.al (2009) stated that studies that establish causal relationships between variables are termed explanatory research. The purpose of this study was to assess the effects of the railway network on the performance of the rail freight operations by assessing the cause-and-effect relationship of variables. The study will assess the relationship in terms of the effect, of one variable on the other. This is therefore explanatory research. This research design responds to both the how and why of the research objective.

In research, there are two types of time horizons depending on the research question. These are cross-sectional which is snapshot research taken at a particular time and longitudinal which is a diary or series of snapshots (Saunders, et.al 2009). So long as this study used secondary data collected for a long period, its time horizon is longitudinal.

3.3 Methods of Data Collection

This research uses secondary data, so it is referred to as secondary research. These refer to the type of data that has already been collected for some other purposes (Kothari, C. 2004). They also include both unpublished and published summaries (Saunders, et al., 2009). This research used the unpublished data which were internally collected in the organization for some other purposes. The data were obtained through consulting the Operation directorate and the supporting directorates and units which are the Rolling Stock directorate, Civil Engineering Infrastructure directorate, Finance directorate, and Rail Safety and Security Unit.

The use of secondary data has the advantage of using fewer resources and is easy to apply longitudinal study. However, there are some limitations in using this type of data including a lack of control over the data quality and that the aggregations may not match the expectations. For quality control and reliability, the collected data were checked to ensure that they pass six assumptions that are required for linear regression. The assumptions are that the two variables should be measured at the continuous level, there should be a linear relationship between the two variables, there should be no significant outliers, there should be the independency of observation, the data should show homoscedasticity, and residuals (errors) of the regression line should be approximately normally distributed. The tool which was used for this analysis was SPSS software version 20.

3.4 Data Processing and Analysis

Data analysis in this study was focus on the causal relationship of the variables. The aim was to establish how one variable affects the other. The statistical method that is suitable for this type of analysis is regression analysis. It is referred to as the process of calculating the coefficient of determination and regression equation by using one independent variable (Saunders, et.al 2009). There are several types of

regression techniques that include linear, polynomial, logistic, and many others. In this study, the regression technique that was used is linear regression because the focus was on assessing the effect of one variable on the other.

4.0 Research Findings and Discussion

Hypothesis testing in this study followed the five steps which started with the formulation of the null and alternative hypothesis, collection of data, performing the statistical test (linear regression), deciding whether the null hypothesis was supported or refuted, and presenting the findings. The finding of this study was related and interpreted while referring to the theories and gaps in the literature reviewed.
For the first hypothesis, the results can be summarized as below

Table 4.1: Model Summary (Derailments Vs Transit Time)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.902[a]	.813	.801	8.62829

a. Predictors: (Constant), Derailments
b. Dependent Variable: Transit Time

The above model summary table shows that R=0.902 or 90.2%, meaning that there is a high degree of correlation. R square = 0.813, meaning 81.3% of the dependent variable (Transit time) can be explained by the independent variable (Derailment), which is very high.

Table 4.2: ANOVA Table (Derailments Vs Transit Time)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4865.053	1	4865.053	65.349	.000[b]
	Residual	1116.711	15	74.447		
	Total	5981.765	16			

a. Dependent Variable: Transit Time
b. Predictors: (Constant), Derailments

Table 4.3: Coefficient Table (Derailments Vs Transit Time)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.013	10.128		.791	.441
	Derailments	.735	.091	.902	8.084	.000

a. Dependent Variable: Transit Time

The ANOVA test and the Coefficient tables show the statistical significance of the regression model that was run. From the tables above, the P-value is less than 0.0001, which is less than 0.05. The Coefficient table below also shows the relationship between the study variables as P-value is also less than 0.05, implying that the null hypothesis is refuted.

For the second hypothesis, the results can be summarized as below.

Table 4.4: Model Summary (Washouts Vs Infrastructure Maintenance Costs)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.950[a]	.903	.879	2.38007

a. Predictors: (Constant), Washouts

b. Dependent Variable: Infrastructure Maintenance Costs

The above model summary table shows that R=0.950 or 95.5%, meaning that there is a high degree of correlation. R square = 0.903, meaning 90.3% of the dependent variable (Infrastructure Maintenance Costs) can be explained by the independent variable (Washouts), which is very high.

Table 4.5: ANOVA Table (Washouts Vs Infrastructure Maintenance Costs)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	211.696	1	211.696	37.371	.004[b]
	Residual	22.659	4	5.665		
	Total	234.355	5			

a. Dependent Variable: Infrastructure Maintenance Costs

b. Predictors: (Constant), Washouts

Table 4.6: Coefficient Table (Washouts Vs Infrastructure Maintenance Costs)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	19.430	1.351		14.386	.000
	Washouts	2.870	.469	.950	6.113	.004

a. Dependent Variable: Infrastructure Maintenance Costs

The ANOVA test and the Coefficient tables show the statistical significance of the regression model that was run. From the tables above, the p-value is 0.004, which is less than 0.05. The Coefficient table below

also shows the relationship between the study variables as P-value is also less than 0.05, implying that the null hypothesis is refuted.

For the third hypothesis, the results can be summarized as in Table 4.10.

Table 4.7: Model Summary (Rail Freight Wagons Maintenance Capacity VS Rail Freight Wagons Availability)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.920[a]	.847	.835	3.21551

a. Predictors: (Constant), Rail Freight Wagons Maintenance Capacity

b. Dependent Variable: Rail Freight Wagons Availability

The above model summary table shows that R=0.920 or 92.0%, meaning that there is a high degree of correlation. R square = 0.847, meaning 84.7% of the dependent variable (Rail Freight Wagons Availability) can be explained by the independent variable (Rail Freight Wagons Maintenance Capacity), which is very high.

Table 4.8: ANOVA Table (Rail Freight Wagons Maintenance Capacity Vs Rail Freight Wagons Availability)

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	743.223	1	743.223	71.882	.000[b]
	Residual	134.414	13	10.340		
	Total	877.637	14			

a. Dependent Variable: Rail Freight Wagons Availability

b. Predictors: (Constant), Rail Freight Wagons Maintenance Capacity

Table 4.9: Coefficient Table (Rail Freight Wagons Maintenance Capacity Vs Rail Freight Wagons Availability)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	17.142	3.303		5.190	.000

	Rail Freight Wagons Maintenance Capacity	.447	.053	.920	8.478	.000

a. Dependent Variable: Rail Freight Wagons Availability

The ANOVA test and the Coefficient tables show the statistical significance of the regression model that was run. From the tables above, P is less than 0.0001, which is less than 0.05. The Coefficient table below also shows the relationship between the study variables as P-value is also less than 0.05, implying that the null hypothesis is refuted.

4.1 Discussion of the Findings

4.2.1 Impact of Derailments on Transit Time of Trains

Derailment occurs when a train wheel and rail lose contact causing the train to come off the railway track. Sometimes derailments may result in a capsize of rolling stock. When derailment happens, it causes the railway line to be closed for some time depending on the extent of the damage. This line closure causes some trains to remain stranded in the line hence affects the performance of rail freight operations by affecting trains' transit time.

The risk of derailments in rail transportation has been a concern in the railway industry and to all stakeholders. Some approaches such as upgrading the track class have been adopted to manage and reduce the risks. The higher the track class, the more stringent are track safety standards, and thus high maximum train speed is allowed (Liu, Xiang et.al. 2011). Upgrading the track class may prevent certain track-related derailment but also increase the risk of certain types of equipment failure that may occur at higher speed and cause derailment also (Liuet, al. 2011). Also, upgraded track class may attract overspeeding by the drivers, which may lead to the risk of derailment.

TRC is implementing a railway track rehabilitation project for the section between Dar es Salaam to Isaka that is financed by the World Bank. The objective of this project is to deliver a reliable open-access infrastructure on the Dar es Salaam-Isaka rail segment (World Bank. 2014). It has significantly improved the track class and reduce track-related derailments in number (see table and graph below).

Table 4.10: Summary of Number of Derailments at TRC on the corridor of study for 2018/2019 and 2019/2020

	2018/2019		**2019/2020**	
Section	**Track Related**	**Rolling Stock Related**	**Track Related**	**Rolling Stock Related**
DSM-MOR	26	20	14	11
MOR-DOM	12	12	17	9
DOM-TBR	9	10	6	4
TBR-MZA	3	5	4	1

Source: Research Data (2020)

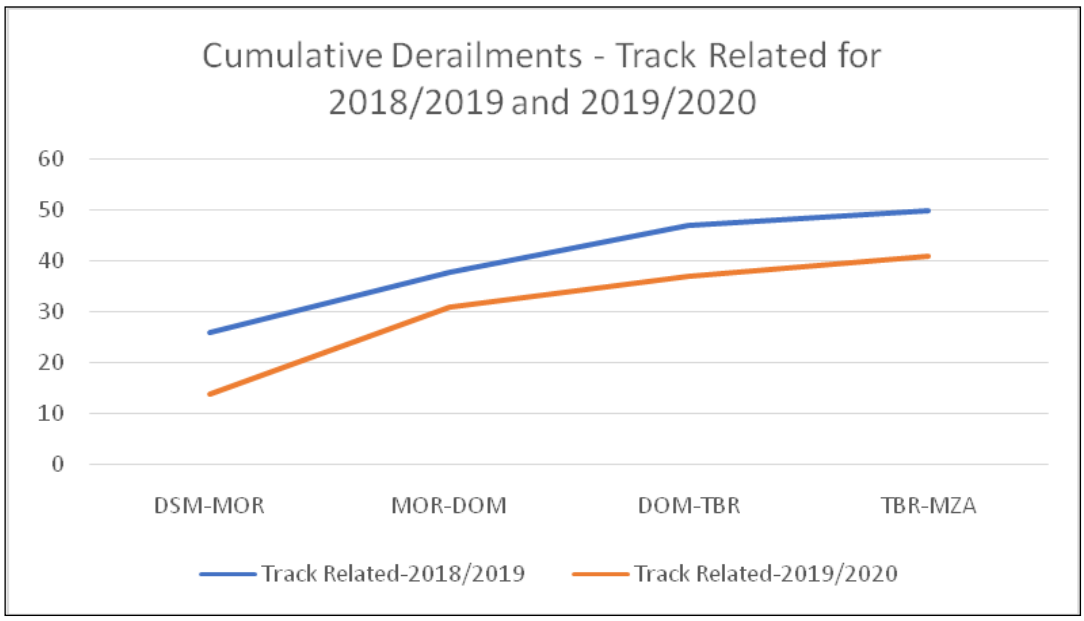

Figure 4.1: Cumulative Derailments (Track Related) 2018/2019 and 2019/2020

However, the effort of upgrading the track class needs to be complemented by the improvement of rolling stock standard and maintenance to subsequently reduce the rolling stock related derailments.

4.2.2 Impact of Washouts on Infrastructure Maintenance Costs

Washout occurs when the whole or part of the track structure is spoiled by constant or heavy rain. In the railway segment selected for this study that is from Dar es Salaam to Isaka, washouts mostly occur on Kilosa-Gulwe to Igandu, which is a section of about 120Km (from Kilometre post 283 to Kilometre post 403). This section is a flood-prone area that is affected by erosion and sometimes sand deposition (TRC 2019).

The research results show that washouts have a direct positive impact on infrastructure maintenance costs. This implies that the increase in infrastructure maintenance cost is also contributed by the cost used for railway recovery due to washouts. Apart from spending a substantial amount of money for railway line restoration due to washouts, TRC also suffers line closure for some time when such disruption happens. As a result of washouts, 90 days was reported as an average number of days of line closure per annum (TRC 2019).

This situation affects the performance of rail freight operations mainly in two ways; one is due to disruptions which cause delays and sometimes restriction of rail freight trains movements and the other aspect is on tariffs which cannot be lowered because TRC is already using much money than expected for infrastructure maintenance per annum.

4.2.3 Impact of Rail Freight Wagons Maintenance Capacity on Rail Freight Wagons Availability

Ballis et al. (2010) stated that the wagon fleet is an essential component in the performance of railway operations. The railroad company should ensure sufficient availability of wagons in the railway system. These wagons need to be well maintained to keep them running.

Rail freight wagons maintenance capacity in this study refers to the level of efficiency that is used to ensure that the rail freight wagons are kept in good and running condition. In TRC there are several stations for wagons maintenance that are active to date. There is one central mechanical workshop located in Dar es Salaam. This attends all the major wagons' faults and rehabilitation of rolling stock in general. There are also several depots for routine and spot maintenance of wagons which are Dar es Salaam (DSM), Malindi (MAI), Ilala (LAL), Morogoro (MOR), Dodoma (DOM), Tabora (TBR), Kigoma (KGM), Tanga (TAN), Mwanza (MZA), Mwanza South (MSO).

The study found that TRC has a 1486 fleet of wagons for Metre Gauge Rail out of which 627 equivalents to 42.2% are in the workshops and depots waiting for major repairs and maintenance. These wagons are not running for some time now. The remaining wagons are in running condition and they are checked several times at workshop and depots for repairs due to aging. The results of this study show that rail freight wagons' maintenance capacity has a direct impact on rail freight wagons availability. This implies that the maintenance efficiency of rail freight wagons affects their availability in the railway system. If many wagons stay in the workshops and depots waiting for maintenance, and they are not maintained on time, the system suffers wagons shortage, hence the performance of rail freight operations is affected.

5.0 Conclusion and Recommendations

5.1 Effect of Derailments on the Performance of Rail Freight Operations

In the trains' operations, the constant contact between the wheel and rail is very important. It ensures safe trains' movement. When the contact is lost, derailment occurs, which may lead to damage to the track materials and the rolling stock. Derailments also interrupt train movements and affect the trains' transit time.

5.2 Effects of washouts on the performance of rail freight operations

Washouts spoil the track structure and result in an interruption to trains movements. The damage due to washouts has to be restored at a cost that falls under the infrastructure maintenance budget. If the frequency of the occurrence of washouts is high then the cost of restoration becomes significantly high. Consequently, if the railroad company spends much money to maintain the infrastructure, automatically the total operations costs will be high and so the tariffs may not be competitive compared to other modes of transportation.

5.3 Effect of Rail Freight Wagons Maintenance Capacity on the Performance of Rail Freight Operations

A high level of efficiency of rail freight wagons maintenance implies high capacity. Because rail freight wagons are continuously in operation, they need to be maintained to keep them running. If no sufficient effort for maintenance, the rail freight wagons will stay longer in workshops and depots hence results in insufficient availability of such wagons in the railway network, which in fact, affects the performance of rail freight operations.

5.4 Recommendations

The study has used the Performance Measurement theory with the Balanced Scorecard model for measuring the performance of Tanzania Railways Corporation on rail freight operations. The method is therefore recommended for measuring the performance of railroad companies. The findings of the study indicate that derailments, washouts, and rail freight wagons maintenance capacity affect the performance of rail freight operations. Railroad companies should put forth strategies to reduce derailments. The major cause of the derailments being the track and rolling stock fault, the railroad companies should allocate more budgets on track and rolling stock maintenance.

Also, a permanent solution should be obtained for frequently occurring washouts to avoid spending more on temporary restorations. Further to that, the Government and other investors should look at the railway sector as a potential area for investment since apart from being a good source of income through rail freight operations, it also boosts the economy by supporting the growth of other sectors.

5.5 Areas for further study

It is recommended that further study on a similar subject can be conducted to assess the external factors affecting the performance of rail freight operations. The study can focus on the customer perspective. This may assess how the rail freight customers view the performance of rail freight operations and come up with more areas for improvement to increase rail modal share.

6.0 Acknowledgement

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Availability of raw materials in the state of Piauí for the production of ceramic coating

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Abstract

The main raw material for the production of ceramic materials is clay, it can be found in large quantities throughout Brazil, in addition to having a simple processing method in the preparation of the mass of ceramic tiles using mixtures of kaolinitic clays (not very plastic) and illitic (plastic) clays, this mixture favors by developing a series of functions such as: light-burning color; act as binders and plasticizers; facilitate fluidity, due to its melting properties, provide a good burning density and excellent mechanical resistance.

This work addresses the main basic white-burning raw materials used in the production of ceramic tiles: quartz, kaolin, talc and limestone and their influence on the ceramic mass. All raw materials mentioned are available in the State of Piauí. For this, a bibliographic review of a descriptive, basic and qualitative nature was carried out on the theme and with the results, it was possible to identify the existence of white-burning raw materials in the State of Piauí that can be used in the production of ceramic coating.

Keywords: Raw material; Coating ceramics; Clays.

1. Introduction

The ceramic sector plays an extremely important role in the country's economy. According to studies carried out by ANFACER (National Association of Ceramic Manufacturers for Coatings, Sanitary Ware and the like), Brazil is one of the main players in the world market for ceramic tiles. Occupying the third place in production and the second place in consumption in the world and besides being the sixth in the ranking of exports. With productive concentrations in the south, southeast and northeast (ANFACER, 2018).

Thus, the ceramics industry ended up attracting high investments in training, installation costs and applied technology. Ceramic materials exhibit a wide range of properties, comprise all non-metallic inorganic materials, usually obtained after heat treatment at high temperatures, are the basis of cheap raw materials and are widely used in several areas of knowledge. Its main raw material for the production of ceramic materials is clay, which becomes very plastic and easy to mold when moistened, and can be found in a large quantity throughout the Brazilian territory (SANCHES, 2012).

As the name implies, ceramic tiles or ceramic tiles are used to cover floors, countertops, walls, pools and even ceilings inside and outside the environment. When used as floor coverings, they are called floors. When used as a wall covering, they are called tiles, tiles, tiles. (OLIVEIRA and HOTZA, 2015). The ceramic tile sector generally uses other types of classification, such as: floors and coverings (depending on how they are used) on the floor or on the wall; white or red burning ceramic plates, depending on the color after firing (SANCHEZ et al., 1996).

One of the main reasons why the Brazilian ceramics industry has grown rapidly is due to the excess of natural raw materials. That is why it is important to choose the raw materials, the formulation of the ceramic mass, the compaction of the product and the burning conditions, as they determine the physical and chemical transformations occurred during the manufacture of a ceramic product, thus influencing its final properties (OLIVEIRA, 2011).

Currently, ceramics is considered an intense object of research, considering the use of its physical and chemical properties of a large number of materials. Studies have shown that another region that has shown development in this sector, due precisely to the wide variety of raw materials in the area and the developing consumer market is the Brazilian Northeast.

In Piauí, the ceramic tile industry is a segment that has been experiencing difficulties, as there are some factors that hinder this manufacturing, such as a high cost of raw materials, which makes production expensive, a significant loss of production and in In particular, the lack of knowledge about other raw materials that can be applied to the ceramic mass. Thus, there is an abundance of products that are

considered of inferior quality when compared to products from other regions and available in the Piauiense market (SOARES, 2008).

Another important factor is the lack of technological support, as well as the lack of research that makes it difficult to improve the quality of the coating ceramics produced in Piauí. As a result, these products end up becoming less competitive and with low market value. With the improvement of the ceramic quality manufactured in Piauí using raw materials specific to the State, it would end up becoming a viable economic alternative, as it would develop the existing industry, thus generating investments in the sector and jobs and income for the State (SOARES, 2010).

Therefore, this work addresses the main basic white-burning raw materials used in the production of white-based ceramic tiles: quartz, kaolin, talc, limestone, showing their availability in the State of Piauí and their influence on the mass.

1.1 Raw materials

The term "raw material" refers to all materials that are incorporated into the product during the manufacturing process. Ceramic raw materials can generally be divided into: plastics, which are clay minerals, ie clays and kaolin and non-plastics, which are fluxes, quartz and talc. Both have important functions throughout the ceramic production process. In the conformation phase, plastic raw materials are essential, as they confer important characteristics, such as plasticity and mechanical resistance, while in the thermal processing phase, non-plastics act, which confer characteristics such as, structure and color (MOTTA et al., 1998).

Clay materials are highly fine materials, so they can provide a mixture with high cohesion and processability, making these products with excellent plasticity and ease in the process of coating execution (RECENA, 2017).

According to Santos (2009), the main function of fluxes is to make the existing impurities more fusible. Limestone, dolomite, feldspar, manganese oxide and iron oxide are the main fluxes in the manufacture of coatings. In the blast furnace, these fluxes burn silica.

In the production of ceramic tiles, there is not a single raw material, as with bricks and ceramic tiles, because to form a good formula, with good stability and good meltdown, it is necessary to mix several raw materials with different chemical properties. Heck, (1996, p.21) affirms "it is essential to maintain the homogeneity of the batch and to meet the specifications, in order to avoid variations in tonality and variations in the melting point of the composition".

The selection of raw materials that make up the ceramic mass must have the required characteristics of the product and the basic criteria of the characteristics inherent to the manufacturing process, which depend on the chemical and mineral composition of each raw material used (SOUZA et al., 2000).

Knowledge of the chemical composition (presence of main oxides) and mineralogy (crystalline phases) of the composition of the ceramic mass is essential to predict the behavior of the mass and the characteristics of the final product throughout the manufacturing process. It also guides the proportion of each component, in order to optimize the entire processing through economic benefits and to improve the technical and aesthetic qualities necessary for the ceramic body. Generally through mineralogical analysis, chemical composition analysis, differential thermal and thermogravimetric analysis, granulometric analysis,

plasticity index and determination of physical and mechanical properties with temperature changes, they are used to study raw materials and determine their technical uses (SOARES, 2010).

Silicon oxide (SiO2), aluminum oxide (Al2O3), potassium oxide (K2O), sodium oxide (Na2O), calcium oxide (CaO), magnesium oxide (MgO) and iron oxide (Fe2O3), are the main oxides found in the raw materials of a ceramic coating mass and each one has a specific function during the productive processing and will confer the final properties of the ceramic product (SANTOS, 1989).

SiO2 is usually associated with clay, fluxing and quartz minerals. It is the main glazing agent and makes up the main crystalline phases after burning. Free silica reduces plasticity, lowers linear shrinkage, facilitates the drying process and the release of gases during firing. Al2O3 is mostly combined to form clay minerals. It is also a glass-forming agent when combined with fluxing agents, and when present in large quantities it increases the refractoriness and loss to fire of the mass. At the end of the firing, it is part of the crystalline structure, such as mullite for example (SANTOS, 1989).

Alkaline earth oxides (CaO and MgO) are generally derived from calcium and / or magnesium carbonates. They are melting agents and tend to lower the refractoriness of the ceramic mass (SANTOS, 1989).

Fe2O3 comes from iron minerals such as hematite, magnetite, limonite, lepidocrocite, geotite and pyrite, often found in clays. Iron oxide reduces refractoriness and acts on the coloring of the ceramic body, obtaining colors such as beige, yellow, red or brown. The variation in the burning color depends on the concentration of iron in the mass and other constituents such as aluminum and calcium oxides, as well as the burning temperature. At higher temperatures, iron oxide can expand the ceramic piece with the release of gases.

The raw materials that make up the ceramic tiles must always have a low iron oxide content, as this affects the color of the piece produced, because the effectiveness of the pigments added to the composition directly affects the whiteness of the piece (GIBERTONI, 2008).

2. Methodology

The present study is a literature review of the literature review type, which is based on a qualitative and exploratory approach. It seeks to translate the information collected into articles, defining: Availability of raw materials in the State of Piauí for the production of ceramic tiles.

Articles will be collected from the Google Scholar database, from the CAPES and Scielo journals portal, as an inclusion criterion will be used the full articles, published from 2015 to 2020, the following descriptors will be used: White-burning clays; white-burning ceramic coating; ceramic coating; clay. The search will be performed using the words found in the titles and abstracts of the articles. It will also be used for master's and doctoral theses found in universities and colleges, as well as literature related to the theme. In possession of the articles, criteria for inclusion of those articles will be made that the characteristics were more pertinent to the theme, articles with qualitative approach, exploratory, descriptive, and reflexive-descriptive, which are directly related to the subject of the study, and will be excluded the initial search is for those articles that are outside the theme, that is, abstracts and other forms of publication that are not complete scientific works. The research has an exploratory and descriptive character aiming, respectively, to provide more information on the topic addressed, registering, analyzing, classifying and interpreting the

data obtained through review.

3. Results

3.1 Clays

According to the Brazilian Association of Technical Standards - ABNT (NBR 6502/95), clay is a finely classified soil composed of particles smaller than 0.005 mm in size. The clay has plasticity, texture and consistency under natural conditions and humidity. It is easy to mold it into different shapes when fully wet and has sufficient cohesion when dry, which can form clumps that are difficult to decompose under the pressure of your fingers.

For Rocha, Suarez and Guimarães (2014), clays do not represent a specific type of chemical compound, in fact clay is a set of compounds with very fine granulometry and diameter less than 2µm. Another very important characteristic of these particles is that, when moistened with water, they form a mixture with a certain plasticity. Clay is a very common natural raw material in the preparation of a large amount of ceramic tile masses.

The clay has the function of providing plastic properties in green to guarantee the best performance during the compaction of the ceramic body, as well as the wet, dry mechanical resistance and after firing. In addition to having a simple processing method and available in large quantities (RODRIGUES et al., 2004).

Also according to ABNT NBR6502 / 95, clays can be chemically defined as the purest hydrated aluminum silicate. Plastic clays have a very high alumina content (plastic part) and lean clay has a high silica content (non-plastic part). Greater plasticity is also strongly affected by the size of fine particles and the organic matter of the clays.

In the process of preparing the ceramic tiles mass, mixtures of clays are used, both kaolinitic clays (not very plastic) and clays of the illitic type (plastic), this mixture favors, developing a series of functions such as: the light burning color; act as binders and plasticizers; they facilitate fluidity, due to their melting properties, they provide good burning density and excellent mechanical resistance (BIFFI, 2006).

A major concern is the fact that the most frequent contaminating minerals in clays are: iron oxides, pyrite, siderite, titanium minerals, gypsum and dolomite, the shape and type and quantities of these, can modify the properties of clays as mechanical strength, melting point, color and plasticity, as well as influencing the use, process routes and application of clay in the ceramic industry (LUZ and LINS, 2005).

We can differentiate the clays from each other mainly by the association of chemical elements of different nature and by the granulometric distribution. The main categories of clay minerals are kaolinite, illite, halosite, chlorite and smectite. For ceramic tiles, illicit and kaolinite are the most important, and the purest form of clay that we can find in nature is kaolinite (OLIVEIRA et al., 1998).

In his study, Soares (2010), reports that a clay to be considered of good quality used for a certain function it must have an appropriate chemical composition and the quantity of the chemical composition must also be known. The properties of a clay are determined by the presence or absence of oxides of silicon, aluminum, potassium, sodium, iron, magnesium, calcium and others that may be present in lesser quantities.

In the ceramic sector, clays are named according to technical criteria and ceramic jargon, according to their main characteristic evaluated in the firing stage:

- Red or reddish-burning clays: they have a high content of iron oxide (> 4%) and are used mainly in ceramic coating plates with dry prepared pasta;
- White or light-burning clays: they are usually clays kaolinitic with low or no dye oxide content such as iron or titanium and are applied to ceramic coating plates produced by the wet method;
- Fusing clays or gresified: they are composed of a mixture of clay minerals, which include illite, kaolinite and smectite, with varying proportions of quartz and other non-plastic minerals, with the presence of melting oxides (MOTTA et al., 1998). They allow to obtain interesting values of rupture module in green (wet and dry) and also after firing, since they generally give rise to gresified materials. These clays are used in Brazil in the dry production process and have a reddish color;
- Carbonate clays: present a quantity of calcite, dolomite or magnesite in the variable clay matrix, which can reach high values. The mineralogical associations present in these clays can beilíticoclorítica and eventually ilíticocaulinítica. These clays also contribute to give the dough plasticity and, usually after firing, they are beige-orange in color due to the presence of ferrous minerals (OLIVEIRA, 2000).

In the last two decades, the vigorous development of the ceramic tile industry in the world and in the countries has led to a strong increase in the demand for plastic clay. This demand promoted new producers to enter the international market. Many countries have not differentiated plastic clay from ordinary clay (OLIVEIRA and HOTZA, 2015).

The clay has a high concentration of SiOtwo. This oxide is the main vitrifying agent and makes up the main crystalline phases after burning. Free silica improves the dimensional stability of ceramic parts and facilitates the gas release process during the sintering of ceramic bodies. Clay also has a considerable concentration of aluminum oxide, which is a glass-forming agent when combined with fluxing agents, helps to increase the fire loss of the ceramic mass and at the end of the firing is part of the crystalline structure, such as spinel and mullite. The presence of these oxides together is responsible for the refractoriness of the clay (AVELINO, 2019).

3.2 Kaolin

The term kaolin can be used to name kaolinite-containing rocks as the main constituent and can also be used for products produced during processing. Kaolin is a fine-grained rock composed of clayey materials, usually low in iron, white or almost white (GRIM, 1958).

For Luz and Ribeiro (2008), the types of kaolin vary according to their physical properties: brightness, crystallinity, opacity, viscosity and the shape of the particles. Kaolin is related to several impurities, thus not meeting market specifications. Impurities, such as iron and titanium oxides, mica and feldspar, directly affect color and brightness, thus reducing quality. To promote its ideal use, processing operations are necessary, which depended on the intended use. There are two processing processes: dry and wet.

In the production of ceramic tiles, the amount of kaolin varies from 10% to 15%, besides providing whiteness after firing (to make the piece refractory), it is also an important source of aluminum oxide, which during the glazing of the ceramic mass becomes a regulator of the balance of reactions (BIFFI, 2006). In ceramic pieces, kaolin can also be used as an alloy of components in the green state and can also provide plasticity for modeling the body in the presence of water (ALBUQUERQUE et al., 2007).

Kaolin has an important concentration of potassium oxide that is associated with fusing clay minerals. This

oxide is essential for low-porosity (vitrified) ceramics, as it acts as a high level liquid phase builder above 1000 ° C and forms eutectic at lower temperatures (AVELINO, 2019).

3.3 Quartz

Quartz, an allotropic form of silica at room temperature, is one of the purest and most abundant minerals in the earth's crust. Its structure consists of a three-dimensional network of tetrahedrons connected in a compact structure, consistent with its high density. The open spaces in its structure are so small that other atoms cannot enter, which contributes to its high purity. The main sources of quartz for the ceramic industry are sandstones and quartzites made up of connected quartz grains (NORTON, 1973).

In nature, quartz exists in polymorphic forms: tridymite and cristobalite. As the temperature changes, phase changes occur and each phase change has its own specific name. Alpha quartz, the most common of the polymorphs, is stable at room temperature, becoming beta at 573 ° C with an increase in volume of around 3%, and tridimite at 870 ° C. At a temperature of 1470 ° C, the transformation to cristobalite occurs, up to the melting point at 1713 ° C (KLEIN and DUTROW, 2012).

Quartz plays a very important role in coating ceramics, because it adjusts the plasticity of the dough, promotes the drying step and the escape of gases during the firing process, guarantees the stability of the pieces, regulates the viscosity of the liquid phase formed during the burning and the thermal expansion coefficient (FERRARI et al., 2000). Despite having a very important function, quartz is a low-cost raw material.

For Albuquerque et al., (2007), quartz acts as a filler, with the sintering temperature being the stable phase, reducing shrinkage, that is, it plays a role in controlling the expansion and distortion of the ceramic piece. It is also used to reduce the plasticity of the raw material mixture and increase the permeability of the raw material.

Quartz sand is used to maintain the structure in the mass when, due to the increase in temperature, the other components melt. In addition, it is an important regulator of the relationship between silica and alumina for the formation of mullite, a phase that increases the resistance of the pieces. It presents a considerable amount of silicon oxide (SiO2), thus proving the purity of this material, on the other hand it presents a low amount of aluminum oxide. Quartz will help reduce the shrinkage of the mass, since during the formation of the liquid phase it will behave as if it were the “skeleton” of the material. (AVELINO, 2019).

The author above also mentions that, in general, the thermal behavior of sand is very similar to that of clay. This is due to the similarity in the chemical and mineralogical composition of these raw materials.

3.4 Limestone

Limestone is a rock composed mainly of calcium carbonate and can appear in the form of calcite or aragonite, the latter being an auxiliary substance for minerals. In the earth's crust, there is almost no limestone composed only of calcium carbonate (Holanda et al., 1987).

Limestone is a natural substance of the highest importance for industries and occurs in sedimentary deposits forming white or more or less regular layers. It is a calcium carbonate, sometimes pure, sometimes containing proportions of iron, manganese, alkaline salts, magnesium, silica, alumina, clay, etc. It is introduced into the masses in the form of fine powder and sometimes by the clays themselves as a calcium

compound. It is important to emphasize that the limestone concretions should be finely ground or removed, if possible, because if the limestone, even if ground, is abundant, it may deform the ceramic bodies when burned at high temperature (SENAI, 2006).

The addition of 1% lime to a mass has the same melting power as 10% feldspar, at temperatures above 1100ºC. The use of limestone in the masses makes them lighter and improves thermal expansion, in addition to increasing mechanical strength. In the ceramic tile industry, limestones are used for the manufacture of tiles and some types of floors (SENAI, 2006).

3.5 Talc

Talc is a hydrated magnesium silicate with theoretical mineralogical composition. Its application in the mass of ceramic materials has the following objectives: to change the melt to react with feldspar at lower temperature to form a eutectic reaction; reduce the glazing temperature of the pasta; accelerate the densification of the material; form a crystalline phase with high mechanical resistance and improve resistance to thermal shock during rapid firing cycles (VIEIRA et al, 2007);

In Brazil, numerous studies have already been carried out involving directly or indirectly light-burning clays, so we can highlight:

- CARDOSO et al 1998 describes a study carried out on raw materials used by some traditional white ceramic industries in the state of São Paulo. In this work, the author evaluates five kaolins, a ceramic filite and four ball clay, raw materials from different Brazilian states;
- CARVALHO, 2000 carried out a mineral research in an occurrence of clays in the valley of the Baldun River (RN), evaluating the technical and economic viability of the exploration of this deposit. The author verified a reserve of 51,702 tons that can be used in the white ceramic industry;
- MELO et al, 2002 developed a study of four clays from some regions of Rio Grande do Norte. The author found that clays can be used in the white ceramic industry.
- MOTTA et al, 2004 presents the geological and technological characteristics of plastic raw materials used by the traditional ceramic industry, including light-burning kaolinitic clays;

4. Conclusion

The main basic white-burning raw materials used in the production of ceramic tiles were studied: quartz, kaolin, talc, limestone, and how these raw materials positively influence the ceramic coating mass. Piauí's raw materials are viable and of good quality for mass applications of ceramic tiles. All of these raw materials are fundamental for the composition of the various masses of the clay-based ceramic industry, also called traditional ceramics, and their good supply constitutes a competitive factor for the Brazilian ceramic sector, in the domestic and foreign markets. However, despite an apparent balance between production and consumption, the supply that meets the different market specificities is not yet complete.

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The relationship between Investments to Increase Human Capital in the HEI and the Return on Intellectual and Integrative Capital

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ABSTRACT:

This article has as goal to compare the investments of Human Capital by the Humans Resources sector of institutions of a private administrative nature with the variation of Intellectual and Integrative Capital and to determine the relationship between the involvement of human resources with HEI and their title. From the reach of these goals, the problem will be answered: which is the relationship between the investments to increase the Human Capital in the HEI and the return in Intellectual and Integrative Capital? The hypothesis that guides this article are: there is no increase of Intellectual and Integrative Capital after teaching qualification. The data were analyzed qualitatively with the construction of inferences, deductions and inductions in dialogs with theoretical aspects. The results showed that there is no proportional relationship between the increases of human resources and the Intellectuals and Integrative Capitals. In some cases, it actually decreased.

Key words: Human Resources; Human Capital; Intellectual Capital; Integrative Capital.

1. INTRODUCTION

Being able to measure and qualify the intangible assets becomes fundamental to differentiate yourself in the market because we are at a time when most of the human production and wealth of nations are in the field of knowledge and ideas. Nowadays, the wealth of nations is given by the power of producing ideas, knowledge and technologies that are transformed into the most varied services.

The physical material world begins give way to the immaterial, soon the intangible will be part of the companies' world agenda, whether of visible products and/or services because, even the ones of products manage to sell more when the subjective assembled to it reaches more the population.

In the institutions of higher education, the immaterial is more evident because the work's object is, for its nature, intangible: production of knowledge. It demands a constant upgrade of human resources hired by the HEI in order to ensure the quality of classes, operation object. In fact, the quality standards determined by the regulatory organs shows a higher value to the HEI's that have HR with bigger Human Capital (titration).

This scenery makes the HEI's of private administrative nature invest financial resources to help its HR to obtain a bigger titration with the increase of Human Capital and they expect the proportional increase of Intellectual and Integrative Capital, because these are more related to the HEI than to the HR. However,

it is known that the Human Capital (titration) serves to value the HEI but are centered in the HR, because when it leaves the HEI, it needs to replace this Human Capital.

Therefore, is problematized with the questioning: which is the relationship between the investments in increasing the Human Capital in the HEI and the return in Intellectual and Integrative Capital? In the context of this question, the goals of the article are two: compare the investments of Human Capital by the sector of Human Resources of the institutions of private administrative nature with the variation of Intellectual and Integrative Capital and to determine the relationship between the evolvement of human resources with the HEI and its titration. Already regarding the hypotheses:

H_0: There is no increase of Intellectual and Integrative Capital after teacher's titration.

H_1: There is increase of Intellectual and Integrative Capital after teacher's titration.

2. METHODOLOGY

In the universe of private institutions of higher education, a HEI was chosen for presenting some characteristics such as good results in the ministry of education, being a known brand in the Bahia's North East and Sergipe's South Center (Brazil) and many of their teachers seek alternation of level, in their titration of specialist to master and from master to doctor.

Regarding the teachers, the population was composed by teachers that consisted in the data base of HEI from 2012 to 2019.1 totaling 120 teachers with selection for sample the teachers who were hired as specialists or masters and changed their titration staying in the HEI in the meantime. Therefore, the sample was composed by 16 teachers which 11 changed their titration of specialist to master and 5 from master to doctor.

Once chosen the HEI, it was researched the data in its academic portal available online where there was all the information needed to carry out data collection identifying the teachers described in the institutional portal with selection of teachers that changed their titration from specialist to master and from master to doctor keeping bond with the HEI.

Then, it was analyzed the *lattes* curricula to categorization of productions in Human, Intellectual and Integrative Capital. Were compared present data in the curricula of the teachers before and after titration, assigning quantitative and qualitative value to the capital produced by them with statistical analysis repeated measures t-test.

It was also analyzed the data referring the teacher's career plan, course matrices, academic schedule and official documents from the IRS. All of these data were analyzed for the verification of the ratio of increased human capital in proportion to financial increase and return in terms of Intellectual and Integrative Capital.

The data were analyzed in qualitative way with inference, deductions construction and inductions in dialogs with the theory which results are construction of concept and hypothesis formulation from the data analysis. (SILVA *et al*, 2010).

RESULS

The results are presented in three tables. In the first table there are variations of three kinds of

Human, Intellectual and Integrative capital with correspondence to each kind of capital with t-student test application which showed that there were no differences between the slopes of the lines before and after the titration. In the second, it was presented the percentual increases from specialists to masters and from masters to doctor and, in the third one, the values paid by hour in class in the HEI reference.

Table 1: Production Variations of HC, IC, *INC* After Titration

Teacher	Titration	HC Variation	IC Variation	INC Variation
Tchr. 1	Master	-0,02	0,00	-10,0
Tchr. 2	Doctor	0,01	0,07	-0,17
Tchr. 3	Master	-0,90	-0,34	12,0
Tchr. 4	Doctor	0,05	-3,50	13,0
Tchr. 5	Master	-0,80	-0,05	-3,00
Tchr. 6	Master	0,10	0,03	-2,50
Tchr. 7	Master	0,50	0,10	0,18
Tchr. 8	Doctor	-2,75	-3,75	-0,20
Tchr. 9	Doctor	-0,80	-0,30	-14,0
Tchr. 10	Master	-7,00	-2,00	-1,60
Tchr. 11	Master	0,50	-0,20	-11,0
Tchr. 12	Master	-0,30	-0,30	-1,30
Tchr. 13	Doctor	2,50	-0,35	0,50
Tchr. 14	Master	0,70	-1,75	-1,00
Tchr. 15	Master	0,90	-0,95	-2,50
Tchr. 16	Master	0,02	0,00	0,50

Source: (BEZERRA; DE-BORTOLI, 2021).

According to data in table 1, which compares the variations after titration of the three Human, Intellectual and Integrative capitals, only two teachers presented positive variation in the three capitals corresponding to 12,5%. Teachers number 7 and 16, both masters, in other words, there is no doctor with positive variation in the three capitals.

It should also be noted that both the maximum variation was 0.5 in Human Capital for teacher 7 and Integrative Capital for teacher 16. The remaining variations were below 0.2, with 16 remaining stagnant in Intellectual Capital.

In other words, it can also be said that fourteen teachers have at least negative capital, which means 87.5% in percentages and nine have at least positive capital, which is 64.3%.

Five of these teachers presented negative variation in the three capitals corresponding to 31,25%. Teachers number 5, 8, 9, 10 and 12. Of these, number 9 and 10 are doctors, that is, 40% of teachers with negative values for the three capitals are doctors.

It should also be noticed that only 5 teachers have a variation lower than 1. The others have a superior predominance to 0,5. In everyone there is at least a value superior to 1. Here, comes to attention

the high values of variation like 9 that had -14 for the Integrative Capital and, 10 that had -7 for the Human Capital.

When comparing the three capitals, the only one that showed a positive predominance was the Human Capital with the teachers 2, 4, 6, 7, 11, 13, 14, 15 and 17, only three; and the ones numbered 1 and 16 were stagnant. The Capital with the lower positive value was the Integrative with only the teachers 3, 4, 7, 13 and 16, that is, five teachers.

Regarding the investment in the Human Capital by HR, in HEI's career plan there is a vertical progression in terms of titration, that is, there are percentage increases in salary when going from specialist to master and from master to doctor, as shown in table 2.

Table 2: Increase of salary values to be paid by titration – Career plan

ESPECIALIST/ MASTER	19,60%
MASTER/ DOCTOR	16,24%

Source: (BEZERRA; DE-BORTOLI, 2021).

In the career plan there is also the value of the hour per classes for the specialist, master and doctor, as shown in table 3, highlighting the exclusivity contract being 20 hours for teaching and 20 hours for other academic activities, via project presented by the teachers, regardless of whether the project is presented or not, the value remains the same and, if submitted and executed, it will be increased in proportion to the hours of the project.

Table 3: Total values of hour/class to be paid in the HEI reference

	4h weekly	**Monthly values**
Specialist Value	R$ 923,09	R$ 120.001,70
Master Value	R$ 1.104,03	R$ 143.523,90
Doctor Value	R$ 1.283,20	R$ 166.816,00

Source: (BEZERRA; DE-BORTOLI, 2021).

In terms of quantitative values, considering the two tables, without taking into account the other academic activities for the 20 hours that the HEI pays and charges, and considering 130 hours of a course, when going from specialist to master there is an increase of R$ 23 522.22 and a master's degree and 23 292.1.

When considering the sample, 11 professors went from specialist to master and 5 from master to doctor, it is clear that there is a considerable increase in the payroll, due to the incentive for titration by human resources.

DISCUSSION

In order to facilitate the reading process of the elaboration and presentation of the discussion's results, the data and / or information scheme will be followed in an enumerated and didactic way, followed

by the elaborated inference, with further discussion.

- Data 1- Human Capital with 57% of positive variation.
- Inference 1- It's the capital with more direct relationship with the HEI.

According to Moura, Ferreira, Sousa e Pontes (2005), the management of Human Capital in the HEI's has invested in the professionalization of its teachers, creating policies to encourage titrations and training, participation in academic events such as congresses, forums, seminars, training and motivations to expand their knowledge and use them in innovation, however, they need to build criteria to realize these investments in added value for the brand, as well as financial.

For Spinelli (2015), the human capital is one of the fundamental IAs for organizations to have a competitive advantage with survival in the market and, therefore, must have professional and personal skills consistent with its new dynamics, which requires investment in HC with training congruent to the company's objectives in order to efficiently and quickly produce what they need.

According to Quimara e Sepúlveda (2018), a non-coherent evaluation of IA has negative consequences in the economic and social field because it reduces the possibility of expanding other capitals such as HC and IC, which requires management to carefully analyze the choice of the best methodology to value IA.

To Engelman *et al.* (2015), the IC has a direct influence on how the organization expands the HC for the processes of acquisition, assimilation and use of the values arising from the IC whose transformation of knowledge must exert a uniform influence on the various capitals of the company, with emphasis on innovation.

As the HEI, in study, helps in the teacher's qualification (investment of Human Capital in their Human Resources – HR) there is an expectation that, also, increases the Intellectual and Integrative Capitals of this HR. If it does not happen, it would be simpler to hire the titled already correspondent to the criteria of MEC's evaluation and avoid the questions of adaptation and flexibilization of schedule, adjustments on work's demands and own investment.

- Data 2- Intellectual Capital with 62,5% of negative variation.
- Inference 2- Produced to join master's and doctoral programs.

Studies and researches made by Nicollini, Torres, Macedo and Câmara (2014), with 2952 administration courses in Brazil, there was a very weak relationship between the number of master professors and doctors in the course and the performance of graduating students at ENADE with less than 40% showing an improvement in the academic quality of the student associated with the expansion of the master staff and doctors.

According Trindade, Barbosa and Bouzada (2017), there is no practical and empirical research evidence to support the idea that the professor with a master's degree and a researcher doctor have a higher teaching performance, even so, there is a very firm belief in this relationship, believing that it is

always positive.

. Pan, Cotton and Murray (2014), on the other hand, suggest that each HEI should study better the relationship between academic qualifications and performance in their HEI in order to perceive points of convergence and divergence, the nexuses and discontinuities with teaching in order that management acts better in this relation when considering institutional objectives.

And for Meyerson e Massy (1994), the intensity relation of the titleholder research is presented in two distinct moments. In the first moment this relation presents a positive curve and, from a determined moment, tends to decrease showing the negative curve.

To. Budovich and Nadtochiv (2019), the teacher's IC evaluation must be fulfilled in five steps. In the first moment, called zero step, it is presented the goals, ways and principles, such as the people who will do the evaluation. The first step corresponds to self-evaluation considering what is foreseen in the work plan. In the second, the evaluation is carried out by the pair teachers of the HEI and others, administrations and specialists. In the third, occurs the evaluation carried out by the students. And, finally, at the fourth are discussed the results with the teachers for the feedback and consideration.

To Machado (2008), one of the ways of making teachers act after titration, for further the classes, would be a better measure of Intellectual Capital with the construction of specific indicators according to the characteristics of each organization to serve as an evaluation process, since it is an intangible asset and, therefore, loaded with subjectivity, but in need of metrics to add value to the HEI.

According to Stefano and Son (2018), manage IC is find strategies to organize process and technologies built initially in the cognition for further transformations of these information in knowledge of an IC in the culture of organization, which requires the comprehension of concepts, evaluations, measure of these actives and elaboration of tools for this management capable of an evaluation with capture, identification, systematization and application of information in the production of knowledge that will be used to boost the organizational strategies with wide performance.

Budovich and Nadtochiv (2019), recommends that for the HEI being able to evaluate the IC of the teacher with more quality it must be done by parts of each component the indicators of predictable goals by HR; time of service; participation and involvement in the academic activities; work regime; and costs invested in the teacher.

Thereby, it is important that the HEI invest in the academic process of the teachers with incentives for titration, for scientific production and professional qualification, but it also needs to follow and observe the arising results of this process in order to generate competitive advantage in their HEI from these data according with the institutional goals because, if it does not happen, it can only be an indicator that it has a HR with knowledge.

- Data 3- Integrative Capital with 68,75% of negative variation.
- Inference 3- Produced to join master's and doctoral programs.

In research made by Reis and Horvath (2014), in a period of four years with 76 teachers from the accounting sciences course of the paranaense HEI, the results showed that the teachers are partially fulfilling their assigned function, according to legislation, it must be further than teaching and extension,

including the research because most of the masters and doctors in the four years had few publications and 33,45% of the sample didn't write any article.

For Trindade, Barbosa and Bouzada (2017), the aspects of the teacher intellectual IC indicates a direct and positive relation with the improvement and quality of HEI's services, in special, in the student performance are training and professional development; experience in the exercise of the magisterium; remuneration; work regime; experience in orientation, including, in relation to student retention; and, finally, pedagogical practice.

Bak and Kim (2015), when there is a politic to incentive for titration and academic production without results monitoring of this investment, it can have an opposite result because the teachers may concentrate their energy in the IC and prejudice the teaching quality.

Nicollini, Torres, Macedo and Câmara (2014), there are two aspects that must be considered when wanting to studying courses quality reflecting on the performance of graduates associated with the number of masters and doctors in the teaching staff. The first is that the master's and doctoral degrees do not focus on the development of teaching skills such as didactics, learning mediation and how one can learn to seek the best forms of teaching and, secondly, HEI must have masters and doctors to attend the assessment of the parameters for MEC's evaluation, which makes them to no longer have teachers with excellent teaching practices and extensive experience in teaching because they are specialists, which can make the courses to have losses in teaching practice.

Trindade, Barbosa and Bouzada (2017), the relationship between the degree of the professor and the quality of teaching is so conflicting that, in addition to the lack of strong evidence in favor of the positive, there are findings that shows the opposite with the defense that these teachers discredit teaching in favor of research.

Therefore, it is important for the HEI to verify how the process of pedagogical training of the total number of teachers is going, because the fact of presenting the titration does not necessarily mean an improvement in the teaching/learning process, since the titration focused more on research than on teaching and , in addition, it should be considered what was agreed with the teacher in relation to what was expected of him after the titration in terms of improvements in the teaching/research/extension triad so that the titration is not just the act of fulfilling the evaluations of the MEC.

FINAL CONSIDERATIONS

The data analysis showed that there was an investment of HEI for the expansion of human resources, but it was not followed by an increase of Intellectual and Integrative Capital after titration. On the contrary, there was a decrease in both, showing an inverse proportionality of the relation: HEI's investments to expand the Human Capital X Intellectual and Integrative Capital, that is, the first increased and the other two decreased, confirming the hypothesis that there was no increase in Intellectual and Integrative Capital after the teacher's titration.

Thereby, is necessary a good management of intangible assets resulting from the titration increase, such as clear politics and quality indicators of teachers after titration; and the HEI needs to act to realize the conversion of this investment into positive values, which makes it seek alternatives for joint

measurement of tangible and intangible assets, if this does not occur, it may be making wrong decisions in relation to the intended objectives.

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Biosafety and action in front of COVID-19: What do we know?

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Abstract:

The COVID-19 disease that affected the entire world in 2020 is caused by a virus (SARS-CoV-2) with a high rate of pathogenicity and transmission that caused several deaths in its trajectory. To combat this disease several personal hygiene measures and the use of personal protective equipment were necessary. In view of this, the study aims to clarify some doubts regarding the vaccine and its effectiveness, individual protection and the performance of health professionals in the face of this situation.

Keywords: Biosafety, SARS-CoV-2, Cross Infection, Health Professionals, COVID-19, Personal Protective Equipment (PPE).

1. Introduction

COVID-19 or SARS-CoV-2 is an infection caused by viruses with a high rate of transmission and pathogenicity (SHEREEN et al., 2020). This virus has been known since 2003 under the name of SARS-CoV, however its mutation has been spread around the world still with a doubtful fuse (SHEREEN et al., 2020)

The spread of the virus was very fast, and in a matter of time it was already at the pandemic level (SHEREEN et al., 2020). In view of this, habits had to be enhanced and Personal Protective Equipment used rigorously (ROTHAN; BYRAREDDY, 2020) to avoid cross-infection being just one of the many necessary means in opposition to COVID-19 (ROTHAN; BYRAREDDY, 2020).

The World Health Organization (WHO) has created a set of rules in the fourth edition of the biosafety manual to be applied to the pathogen that is the protagonist of the pandemic (HUI, 2017). According to the WHO (WHO, 2020) several means of combating SARS-CoV-2 and controlling acute respiratory infections are plausible, such as constant hand hygiene, use of 70% gel alcohol and N95 medical

mask or with disposable upper protection (WORLD HEALTH ORGANIZATION (WHO), 2020) . It is of utmost importance the need for adequate disinfectants with proven activity against enveloped viruses, such as the use of hypochlorite, quaternary ammonia compounds and alcohol (WORLD HEALTH ORGANIZATION, 2020a).

Health biosafety laboratories must maintain all appropriate practices and tests for COVID-19 must be carried out in laboratories properly equipped with trained technicians (HUI, 2017).

The present work, based on the information presented, aimed at bibliographic survey of the safety condition achieved from prevention and risk control actions inherent to activities that compromise human health and personal protective equipment (PPE) used by health professionals and its relevance in tackling the COVID-19 pandemic.

2. Materials and methods

This work was produced by reviewing the literature on the Google Scholar, PubMed and SciELO databases, and had as its central theme: "Biosafety and action in front de COVID-19: What do we know", in the following subdivisions: "Biosafety, laboratory tests cross-infection ","“ Review of the action of health professionals in the fight against COVID-19","Myths about early treatment ","Covid-19 and perspectives for the future "and“ Vaccine and our salvation ". In addition, searches were performed using the keywords such as: "Cross Infection COVID-19", "Biosafety and SARS-CoV-2", "Health Professionals", "COVID-19" and "Personal Protection Equipment (PPE)".

The articles were based on descriptors created by the Virtual Health Library developed (http://decs.bvs.br/homepage.htm) from MeSH - Medical SubjectHeadings of the US National Library of Medicine (NLM), which allows terminology in common in Portuguese, English and Spanish.

These search methods led to data from articles by the World Health Organization (WHO). The inclusion criteria for the articles selected for the present research were: articles published in magazines and newspapers indexed in the databases mentioned above; Articles published in the English language; Articles published in the period from 2014 to 2021.

2. Results and discussion

From a literature review with 60 articles, 45 were selected in order to inform and reaffirm health professionals about the importance of using personal protective equipment and the risks of SARS-CoV-2 transmission to the population.

2.1 Laboratory tests and cross-infection

According to the WHO (WHO, 2020), means of combating SARS-CoV-2 are essential and they are: constant hand hygiene, use of 70% gel alcohol and N95 medical mask or with disposable upper protection, facial protection as faceshield and gloves (AĞALAR; ÖZTÜRK ENGIN, 2020; JOAQUIM et al., 2020).

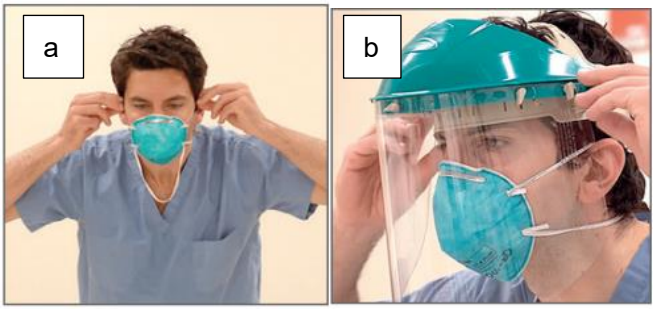

Figure 1: a - Removal of the medical mask by the elastics avoiding contamination; b - Removal of the faceshield (ORTEGA et al., 2020).

According to the World Health Organization (WHO), biosafety laboratories are a strategic approach to managing risks to human health and ensuring that health laboratories comply with appropriate biosafety practices against the spread of COVID-19 (WORLD HEALTH ORGANIZATION, 2020b). All tests with clinical samples from patients to check for the presence of SARS-CoV-2 must be carried out in properly equipped laboratories (WORLD HEALTH ORGANIZATION, 2020b), with a team trained in the techniques and safety of procedures.

The most effective test recommended by the World Health Organization is the RT-PCR (PEELING et al., 2020), which comes from the English Reverse-transcriptase polymerase chain reaction (RT-PCR) and is an exam considered standard in the diagnosis of COVID-19 (CADARI et al., 2021). In this, the evidence of the SARS-CoV-2 RNA in the sample analyzed in the nasopharyngeal swab scraping (CORMAN et al., 2020) occurs by the reverse transcription polymerase chain reaction (STRUNK et al., 2014).

Given the need for close contact between healthcare professionals and infected patients to obtain nasopharyngeal or oropharyngeal samples, the possibility of self-collection of saliva will significantly decrease the chance of transmission of COVID-19. In addition, this collection is not comfortable and can cause bleeding , especially in patients with thrombocytopenia (BAGHIZADEH FINI, 2020). Chest Computed Tomography (CT), as a routine imaging tool for diagnosing pneumonia, is relatively easy to perform and can produce a quick diagnosis. In this context, chest CT can provide benefits for the diagnosis of COVID-19 (STRUNK et al., 2014).

The laboratory guidelines on biosafety must be followed in all circumstances to avoid the spread of the virus that has such a high and rapid rate of transmission (WORLD HEALTH ORGANIZATION, 2020b). Laboratories that do not submit to the biosafety recommendations must transfer the samples to national, regional or international reference laboratories with the SARS-CoV-2 detection capacity in force in the biosafety pre-established in the fourth edition of the laboratory's biosafety manual (HUI, 2017).

According to an article published in "*The Lancet Infectious Diseases*", serology tests are recommended for rapid screening of symptomatic individuals from COVID-19 in community settings, without much access to the molecular test (PEELING et al., 2020). A positive result for IgM in symptomatic patients is strongly suggestive of SARS-CoV-2 infection. According to the same authors, this approach is probably more effective in individuals 5 to 10 days after the onset of symptoms. However, it is not recommended for population methodologies in low prevalence environments, as it generates more false-

positive results compared to true-positives leading to a false sense of security regarding immunity in the population, leading to premature easing of public health measures based on misleading disease estimates (PEELING et al., 2020).

In clinical environments, such as hospitals and dental clinics, some standards must be followed to avoid cross-infection and spread of the new coronavirus (MENG; HUA; BIAN, 2020) and according to the same authors, all environments, in general, must follow the steps of dressing, wearing protective masks against the dissipation of droplets and hand hygiene in order to avoid possible contamination (MENG; HUA; BIAN, 2020).

According to the initial view of the United Kingdom's National Health Service (NHS), dentists and their staff should continue to provide routine care for asymptomatic patients with no history of close contact and to discourage symptomatic patients from attending. However many general dentists have reduced routine care so as not to spread COVID-19 among their patients given the social distance measures that were introduced to the population by the British government (COULTHARD, 2020).

Soon after, some recommendations for dental practice were made to prevent and control infections: dentists should take strict personal protection measures and avoid or minimize operations that may produce droplets or aerosols. The four-handed technique is beneficial for controlling infection; the use of low or high volume saliva ejectors can reduce the production of drops and aerosols (MENG; HUA; BIAN, 2020).

At the moment, vaccination is already active in several countries ((THANH LE et al., 2020), but it is still essential to detect diseases early and immediately isolate the infected person from the healthy population (STRUNK et al., 2014).

Cases of early death from the COVID-19 outbreak occurred mainly in the elderly, possibly due to a weak immune system that allows a faster progression of viral infection (ROTHAN; BYRAREDDY, 2020). Diagnostic accuracy can be improved by combining clinical evidence with chest computed tomography (CT) and RT-PCR results, and RT-PCR results should be interpreted according to epidemiological, clinical and radiological factors (PASCARELLA et al., 2020).

2.2 Review of the action of health professionals in the fight against COVID-19

The pandemic is causing a lot of stress in health professionals, due to many different reasons, such as the severity of the infection, the easy spread, the lack of knowledge about the virus, the depletion of personal protective equipment, lack of access to updated information and communication, the shortage of ventilators and beds in the intensive care unit (EL-HAGE et al., 2020; GEORGER et al., 2020). In addition, given the mode of transmission in the virus, exposure to body fluids (saliva, blood, among others) and high amount of aerosol production, as is the case especially with dentists, leave them exposed to a high risk of infection by SARS-CoV-2 (ALI; RAJA, 2020; GE et al., 2020).

Studies have shown that health professionals in general today have satisfactory knowledge on the subject, and those who keep up to date on the virus are more likely to be aware of protective measures during patient care (BHAGAVATHULA et al., 2021; DALKY et al., 2021; MODI et al., 2020).

To solve these problems, the routine in offices and hospitals has changed. For infection control, each patient should be managed as if he were infected, thus carrying out preventive measures (gloves, aprons, goggles, face shields and masks such as N95)(AMATO et al., 2020; IZZETTI et al., 2020; MENG; HUA; BIAN, 2020). Studies have reported that the virus can persist on surfaces for a few days, especially

those suspended in human secretions (KAMPF et al., 2020; KRAMER; SCHWEBKE; KAMPF, 2006; OTTER et al., 2013), so surface disinfection is indispensable not for work environments. Other alternatives were also suggested, such as conducting anamnesis remotely, measuring the temperature when arriving at an office and avoiding companions during an appointment (AMATO et al., 2020)

2.3 Myths about early treatment

Many stem cell studies have shown positive results against the serious symptoms of COVID-19 disease (LOURENÇO et al., 2020). Meanwhile, chloroquine, which is an antimalarial agent with anti-inflammatory and immunomodulatory activities, has gained greater interest as a potential therapeutic option for the management of COVID-19 (KLIETZ et al., 2019). In early February of the year 2020, Wang and associated researchers (WANG et al., 2020) demonstrated in vitro chloroquine activity against SARS-CoV-2 and these findings led to support for the clinical use of chloroquine in China during this outbreak. Although the rationale for this pharmacological dosing regimen remained unclear, it was announced in mid-February that promising initial results have been demonstrated (KLIETZ et al., 2019) and numerous national governors have begun disclosure.

However, on March 28, 2020, there were more than 21 clinical trials underway registered and 3 prophylactic studies evaluating the effectiveness of hydroxychloroquine (HCQ) for the treatment of SARS-Cov-2 (MADEWELL et al., 2020). Of those studies that reported more detailed results and received significant media attention. This way HCQ was proposed in higher doses than those used to treat autoimmune disorders and together with azithromycin (AZM), a macrolide antibiotic (ROSENBERG et al., 2020). However, many authors criticized the study due to the lack of low power, limited follow-up, confusion by indication and lack of adherence to the allocated treatment arm (MADEWELL et al., 2020). The effectiveness of HCQ in combination with AZM, therefore, has not yet been established, but approval of compassionate use by regulators and media attention is likely to lead to an increase in the use of this combination therapy for the treatment of COVID-19 worldwide (MADEWELL et al., 2020).

In the year 2020, the safety profile of hydroxychloroquine was described in its summary, the characteristics of the products, with adverse reactions to drugs, including severe cardiac disorders, such as prolongation of the QT segment (QT represents the repolarization of the ventricular action potentials that is controlled by several ion channels) that can lead to arrhythmia, myocardial arrest or cardiovascular death (MADEWELL et al., 2020; ROSENBERG et al., 2020). In a study by Mahévas (MAHÉVAS et al., 2020) concluded that HCQ did not significantly reduce admission to the ICU or ARDS in patients hospitalized with hypoxemic pneumonia due to COVID-19. In that same study, the authors stated that the results are of great importance and do not support the use of HCQ in patients hospitalized for documented SARS-CoV-2 pneumonia (MAHÉVAS et al., 2020).

Even with all these uncertainties about early treatment, the president of the current moment, persisted in encouraging the population and publicizing in media the use of these drugs that are known to induce cardiotoxicity when used alone, and also increase the risk of other drugs that prolong the QTc (corrected QT) interval (LU et al., 2015). Therefore, it is of utmost importance to understand the safety implications of the proposed combination of HCQ and AZM before this becomes standard practice in the

management of COVID-19 globally since many studies have been terminated due to drug toxicity (MAGAGNOLI et al., 2020)

In a survey (BRUM ELIANE, [s.d.]) it was revealed that the Brazilian president had executed an institutional strategy for the spread of the corona virus. The Center for Research and Studies on Health Law (CEPEDISA) of the Faculty of Public Health (FSP) of the University of São Paulo (USP) and Connects Human Rights since March of the previous year were dedicated to investigating the federal and state rules regarding the new corona virus. From this, a bulletin entitled "*Rights in Pandemic - Mapping and Analysis of Legal Norms in Response to Covid-19 in Brazil*" was produced. According to the same (BRUM ELIANE, [s.d.]) a special edition was recently launched where the research stated the existence of an institutional strategy for the spread of the virus, promoted by the Brazilian Government under the leadership of the Presidency of the Republic.

In addition to positions coming from the national regent not consistent with the national biosafety rule such as inappropriate use of a mask and stimulating agglomeration, the president also, according to the news, becomes explicit against which populations the attacks are concentrated on. According to the report, there are a series of measures taken by the president to prevent workers from protecting themselves from covid-19 and isolating them (BRUM ELIANE, [s.d.]).

Another drug that was suggested against COVID-19 was Ivermectin (JEAN; HSUEH, 2020). However, according to the same authors, the dosage for an action to fight the virus is very high, and the results were only clinical. The proposed dosage for its inhibitory action for SARS-CoV-2 is often toxic, the maximum accepted and according to the same article, to date, no specific medication or therapy against SARS-CoV-2 is formally recommended by the Food and Drug Administration (FDA) in the United States of America (EUA) (JEAN; HSUEH, 2020). In Brazil, due to an excessive use and proposed by the current Brazilian government of 2021, the news "*Ivermectin, like the Bolsonaro government, is not effective against COVID-19*" reinforces that the measured and researchers have said of the action of the medicine against parasites but not for infections caused by the new virus (SAKAMOTO, [s.d.]). In addition, the drug is also leaving sequelae, since several cases of patients with liver cirrhosis are being reported by the medical community due to the chronic use of Ivermectin (NUNES, [s.d.]).

2.4 Covid-19 and prospects for the future

RNA viruses, such as SARS-CoV-2, have high mutation rates, which can increase virulence and pathogenicity of the virus (ABDULLAHI et al., 2020). A major concern in this regard are mutations in the protein Spike (S), responsible for binding the virus to host cells (GURUPRASAD, 2021; ROBSON, 2020).

The coronavirus can become weaker or stronger with time and, as demonstrated in a study, there is a theoretical possibility that in the future the virus will cause milder or more serious effects (NAGY; PONGOR; GYŐRFFY, 2021). According to the same authors, mutations that mild signs and symptoms can facilitate the spread of the virus and thus maintain the outbreak. The mutations that generate a more serious disease, on the other hand, need to be monitored and studied on an emergency basis to avoid further impasses.

With the increase in the number of infected people around the world, the likelihood of new mutations that are successful and cause problems in the effectiveness of already approved vaccines is more

likely (ABDULLAHI et al., 2020). As an example, a new variant of COVID-19, P.1, found in Brazil, in the state of Manaus may reduce the ability of antibodies to neutralize the action of the virus, according to an observation made by the World Health Organization (WHO), being necessary to prove this fact (SILVA, [s.d.]). Therefore, it is once again evident the importance of complying with social isolation, adopting biosafety measures and also promoting and disseminating vaccination as soon as possible before it loses/decreases its effectiveness.

2.5 Vaccine and our salvation

The vaccine is part of a major advance in science, having an impact on longevity and human health (PLOTKIN, 2014). It exposes beings to very small and safe amounts of attenuated substances or dead viruses and bacteria and works by inferring immune responses that are proven to protect against repeated natural infections (PLOTKIN; GILBERT, 2012). It was Pasteur who most clearly formulated the idea of attenuation and demonstrated its usefulness, first with Pasteurella multocida, the cause of a diarrheal disease in chickens (PLOTKIN, 2014). His first approaches involved exposure to oxygen or heat, which played a role in the development of the rabies vaccine and in the famous anthrax challenge experiment in Pouilly-le-Fort (PLOTKIN, 2005).

However, the most powerful technique of serial multiplication of a pathogen in vitro or in usual hosts originated with Calmette and Guérin, who passed bovine tuberculosis bacteria 230 times artificially to obtain an attenuated strain for protection against human tuberculosis (MARTIN, 2006). Later in the 20th century, Sellards and Laigret (LAIGRET, 2005) and, more successfully, Theiler and Smith attenuated the yellow fever virus by serially passing through mice and chicken embryo tissues, respectively.

When you are exposed, the immune system will learn to recognize, attack infections and during the process of developing immunity, the body produces antibodies against specific microorganisms and creates defense (DAI et al., 2019). The next time a person encounters this microorganism, the antibody prevents them from causing the disease or alleviates the severity of the disease, regardless of how the vaccine is made. There are currently four different types of vaccines designed to boost your immune system and prevent serious and fatal diseases (DAI et al., 2019). Live attenuated vaccines contain a version of the live virus that has been weakened so as not to cause serious illness in people with a healthy immune system, such as the yellow wound vaccine. Another common method of vaccine production is the inactivation of the pathogen by heat or chemical treatment, for example hepatitis A (BAXTER, 2007). Subunit, recombinant, polysaccharide and conjugate vaccines are Biosynthetic vaccines that contain artificial substances that are very similar to fragments of viruses or bacteria, the hepatitis B vaccine is an example. Toxoid vaccines are made up of selected toxins that have been sufficiently attenuated and are capable of inducing a humoral immune response such as against tetanus (BAXTER, 2007).

In Brazil, according to the report "*4 vaccines against Covid present satisfactory rates of efficacy and safety; see comparative*", the vaccines that are in circulation are two vaccines: CoronaVac, developed by the Sinovac laboratory in partnership with the Butantan Institute, and the Oxford vaccine, developed by AstraZeneca and the University of Oxford, in partnership with the Oswaldo Cruz Foundation (Fiocruz) (MODELLI, [s.d.]).

Figure 2: Vaccine from the Butantan Institute and Chinese pharmaceutical company Sinovac thrown in BBC News Brazil news (PASSARINHO, [s.d.])

The vaccine will be made available to everyone free of charge by the Unified Health System (SUS), according to the report "*Vaccination against Covid-19 in Brazil: see questions and answers*" which shows several questions that have occurred (POR PORTAL G1, [s.d.]). Vaccination will follow a sequence of priority that, according to the national immunization plan, the campaign's priorities are: people aged 60 or more institutionalized, people with institutionalized disabilities, indigenous peoples living on indigenous lands, health workers, people aged 60 or over more, traditional riverside peoples and communities, traditional quilombola peoples and communities, people with comorbidities, people with severe permanent disabilities, people on the street, population deprived of liberty, employee of the deprivation of liberty system, education workers; Security, Rescue and Armed Forces; Public road passenger transport workers; metro and rail transport workers; air transport workers; waterway transport workers; truckers; port workers and industrial workers (POR PORTAL G1, [s.d.]).

The same reported that in São Paulo soon after the approval of the emergency use of Anvisa, on January 17 began vaccination and on January 18, another fifteen states began to vaccinate the population.

Figure 3: First vaccinated in the country, nurse Mônica Calazans, 54, receiving the first dose of the CoronaVac vaccine against Covid-19 at Hospital das Clínicas, in São Paulo, Photo: Amanda Perobelli / Reuters.

Even the same virtual newspaper emphasizes that it is not possible to contract COVID-19 after vaccination, since no vaccine in tests contains the live virus, therefore, it is impossible for you to be infected when vaccinated (POR PORTAL G1, [s.d.])

3. Conclusion

In this study, we were able to conclude that biosafety is of extreme importance, both for health professionals and patients. In addition, a major step towards science was the vaccine and, being the only cure for the corona virus, its use and its dissemination as soon as possible is extremely important, in an attempt to prevent further mutations from the virus. It is also concluded that dental surgeons, due to the nature of their profession, are subject to high risks of infection, which implies an increased attention of these professionals.

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USE OF ASSOCIATION RULES TO PERFORM THE MINING OF A MARKETING DATABASE COMERCIAL

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Abstract

Currently, companies seek to find methods to analyze their customer behaviors and profiles. From this, a case study was carried out in a drugstore, in which the data mining technique and the Apriori algorithm were applied, for a better understanding. of your sales. First, a bibliographic survey on data mining and its tasks was carried out. Soon the sales made and their respective products were examined. Finally, marketing standards were presented according to the data analyzed, in order to assist the organizational management and marketing of the examined company.

Keywords: Data Mining; Standards; Commercial marketing.

1. 1. INTRODUCTION

Organizational management is one of the pillars for the evolution of a company, as it is related to planning, indicators, goals and organizations, carrying out strategies to obtain positive returns for the institution.

One of the aspects that evolve the management of organizations is the growth of technology, it is easier to assist in this administration, making new discoveries in a large amount of data in a short period of time producing content and reports with advantageous data for the business for decision making.

Therefore, to improve these aspects within an organization, the information technology sectors use the data mining technique (Data Mining), which consists of a study to create standards and relate variables in a

database. Companies that use this method will be ahead of competitors, as it is a differential that has the purpose of forecasting trends, improving the marketing of products according to the customer's profiles. However, this mining is composed by algorithms, one of which is Apriori, which works with association rules based on correlations of elements in a database, with the intention of generating patterns, according to the verification of the acquisition of frequent products of the company.

According to the aforementioned facts, there are some institutions that still cannot understand their commercial plan, putting together a strategic scheme to increase their profits and with the help of technological resources can improve their rate of outflow of items offered to the consumer.

Therefore, in this work, it aims to assist decisions based on patterns discovered about products and sales according to a case study of a drugstore, verifying trends in monthly purchases, in order to contribute to the management of the company as in investments, administration marketing and identification of the most commercialized products with groupings of the items sold.

2. Bibliographic reference

In order to obtain data mining standards using the knowledge discovery method in the database, queries were used with all sales items using the Apriori algorithm and another with groups of product categories. We use (KDD), a non-trivial technique, in which it detects patterns that are relevant, true and current through data analysis with iterative performance because the result of the tasks depends on each other and it is interactive because the activities can be repeated. In which they are composed of several stages:

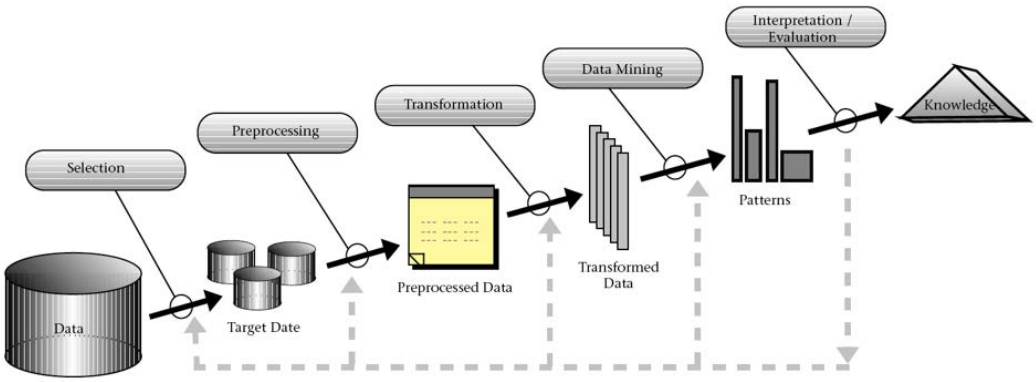

Figure 1- KDD process
Source: Fayyad et al, 1996.

As shown in Figure 1, the first step is the selection consisting of data that will be used in the analysis, which can be set or subsets of data and have different formats, such as structured, unstructured and semi-structured. Where data on the sale item, product and product group tables was selected.

Second, it is the pre-processing, in which the format to be followed will be molded to guarantee the correct delivery, checking the inconsistencies and anomalies that may occur during the process, thus avoiding duplication of data. Where data divergent from the reality of the environment have been eliminated.

Third, Transformation, which techniques are used to improve analysis such as normalization, aggregations, checking if there is a need for new attributes.

Fourth, Data Mining was performed by the WEKA tool, which uses standard algorithms, with significant findings from the data analyzed. The main steps of this process, is the identification of the problem, verifying the goals that must be met, according to decrease data that are not relevant to the case studied, third is to remove insignificant points for the first stage, being necessary to create parameters to verify the usefulness of the information, fourth, would be cleaning as duplicate or erroneous data. Mining tasks are divided in two that aim to specify what will be sought for information, the predictive ones in which the value (dependent or target) of a data based on other values (independent) will be assumed and the descriptive ones which is the pattern analysis, in which checks the relationship of the data.

Therefore, to make data discovery, association rules are used, in this technique, items that are correlated are listed, thus forming a subset of data, such as examining customers who purchased an "X" product, but that there is also a probability of being sold together, the product "Y" from the number of times of transactions. in which it has two parameters: The support is calculated through the ratio between the number of records with a given antecedent to the total number of records (SANTOS, 2004).

$$Is = \frac{Ra}{Tr}$$

Is is the support index
Ra is the number of records with antecedents; e
Tr is the total number of records

And the confidence that is calculated through the ratio between the number of records with a given antecedent and consequent by the total number of records with the respective consequent. (SANTOS, 2004)

$$Ic = \frac{Rac}{Ra}$$

Ic is the reliability index;
Rac is the number of records with antecedent and consequent;
and *Ra* is the number of records with antecedents

And the last phase of this process is the evaluation, a step that is verified if the analysis has valid results for the problem studied, explaining to the person in charge of the business that will make decisions based on the fruits exposed by the WEKA tool, a free software, which consists of a grouping of algorithms to perform data mining, connecting to a Database Management System through another program, such as the Workbench, offering the production, execution and optimization of queries in SQL language.

3. Materials and methods

Through a questioning about the commercial plan of companies, we applied the methodology of a case study of a drugstore in the month of February 2021, producing a large number of significant variables

relevant to a phenomenon, in order to develop knowledge about marketing, using stages the KDD process, such as pre-processing, in which the drugstore base was analyzed, verifying the following tables, customer, product, sale, item sale and product group with approximately fifty thousand sales and one hundred thousand items of sale, carried out by the institution, using the Workbench tool, which manages the Mysql database.

Another step of this process is Data Mining and for its execution, the database was connected to a program that groups algorithms for data mining, generating graphs and discoveries of easy patterns, called Weka, being necessary the use of queries , in order to obtain the tendencies of the enterprise, having algorithms, however the most suitable for our study is the a priori algorithm, which contains value of the transactions, the percentage and the confidence as a parameter.

After making this connection, the product associations were first analyzed according to the drugstore's database, as shown in the following image:

Alcohol in gel	Mask Kit	Dipyrone	Epocler	Soap	Cooling	Vitamin C	Cocktail Shaker	Chocolate
NO	NO	YES	NO	NO	YES	NO	NO	YES
YES	YES	NO	NO	NO	NO	NO	NO	NO
NO	NO	NO	NO	YES	NO	NO	NO	NO
NO	YES	NO	YES	NO	NO	YES	NO	NO
NO	NO	YES	NO	NO	NO	NO	NO	YES
NO	NO	NO	NO	NO	YES	YES	NO	NO
NO	NO	NO	NO	NO	NO	NO	NO	YES
NO	NO	NO	YES	NO	NO	NO	NO	NO
YES	YES	NO	NO	YES	NO	YES	NO	NO
NO	NO	YES	NO	NO	NO	NO	NO	NO
YES	NO	NO	NO	NO	NO	NO	YES	YES
NO	NO	NO	NO	NO	NO	NO	NO	NO
NO	YES	NO	YES	NO	NO	NO	NO	NO
NO	NO	NO	NO	NO	NO	YES	NO	NO
YES	NO	YES	NO	NO	NO	NO	NO	NO
NO	YES	NO	NO	NO	NO	NO	NO	YES
YES	NO	NO	NO	NO	NO	NO	NO	NO

Figure 2- Associations of some database attributes

Source: Own authorship, (2021).

Figure 2 shows the transactions that were carried out during the establishment's purchases, with their respective products, soon we were able to carry out a study on the rules of associations and generate standards that assist in decision making aiming to improve commercial performance.

Therefore, we created an SQL, as expressed below, with the objective of improving marketing, according to sales transactions, such as, for example, checking the best-selling items.

SQL01: Bestsellers itemSELECT

```
IF(max(CASE WHEN itvprocodigo = 2 THEN 1 ELSE  0 END)=1,'SIM','NAO')AS    Álcool_emgel,
IF(max(CASE WHEN itvprocodigo = 5 THEN 1 ELSE 0 END)=1,'SIM','NAO')AS VitaminaC,
IF(max(CASE WHEN itvprocodigo = 9 THEN 1 ELSE 0 END)=1,'SIM','NAO')AS Kit_máscara
FROM itemvenda
```

According to SQL01, we selected the products that had the most outlets during the month analyzed from the item-sale table. And from the best sellers, we also run a query to check products that have a low level of sales for other items in the drugstore.

SQL02: Items with low sales index

```
SELECT
IF(max(CASE WHEN itvprocodigo = 14 THEN 1 ELSE      0 END)=1,'SIM','NAO')AS Sabonete,
IF(max(CASE WHEN itvprocodigo = 23 THEN 1 ELSE 0 END)=1,'SIM','NAO')AS Refrigerante,
IF(max(CASE WHEN itvprocodigo = 20 THEN 1 ELSE 0 END)=1,'SIM','NAO')AS Coqueteleira
  FROM itemvenda
```

In the SQL02 presented, we selected the items that contain low sales rates from the item-sale table. And the third element analyzed, are associations of a product referring to other objects, how many exits were made according to the grouping of frequent combinations, to perform this comparison , the following query was done:

SQL03: Product standards

```
SELECT
IF(max(CASE WHEN itvprocodigo =     2    THEN    1 ELSE     0 END)=1,'SIM','NAO')
AS Alcool_emgel_Giovana_Baby_02,
IF(max(CASE WHEN itvprocodigo = 1 THEN 1 ELSE  0 END)=1,'SIM','NAO')
AS Dipirona_500mg_01,
IF(max(CASE WHEN itvprocodigo = 10 THEN 1 ELSE 0 END)=1,'SIM','NAO')
AS dvd_10,
IF(max(CASE WHEN itvprocodigo = 3 THEN 1 ELSE 0 END)=1,'SIM','NAO')
as Protetor_Solar_Vichy_03,
IF(max(CASE WHEN itvprocodigo = 9 THEN 1 ELSE 0 END)=1,'SIM','NAO')
AS Kit_de_máscara_facil_09,
IF(max(CASE    WHEN    itvprocodigo    =8    THEN 1 ELSE     0 END)=1,'SIM','NAO')
AS Perfume_Alfazema_08,
IF(max(CASE WHEN itvprocodigo =4 THEN 1 ELSE 0 END)=1,'SIM','NAO')
AS Fralda_Huggies_M_04,
IF(max(CASE WHEN itvprocodigo = 5 THEN 1 ELSE  0 END)=1,'SIM','NAO')
AS Vitamina_C_05,
IF(max(CASE WHEN itvprocodigo = 13 THEN 1 ELSE 0 END)=1,'SIM','NAO')
AS Epocler_13,
IF(max(CASE WHEN itvprocodigo = 15 THEN 1 ELSE 0 END)=1,'SIM','NAO')
AS Umidificador_de_ar_15 FROM itemvenda
where    itvprocodigo in (2,1,10,3,9,8,4,5,13,15)
GROUP BY itvvencodigo
```

In SQL03 above, we checked which patterns will emerge from the registered products according to the item sale table in the database, which are sold more frequently from the item groupings. And to improve the organization of the products, the following query was created:

SQL04: Product categories

```
SELECT
MAX(CASE WHEN grupoproduto.grpcodigo=1 THEN 'SIM' ELSE 'NAO' END) AS MEDICAMENTO_01 ,
MAX(CASE WHEN grupoproduto.grpcodigo=2 THEN 'SIM' ELSE 'NAO' END) AS HIGIENE_02 ,MAX(CASE WHEN grupoproduto.grpcodigo=3 THEN 'SIM' ELSE 'NAO' END) AS HHOSPITALAR_03 ,
MAX(CASE WHEN grupoproduto.grpcodigo=4 THEN 'SIM' ELSE 'NAO' END) AS COVINIENCIA_04
FROM produto,itemvenda,grupoproduto WHERE
itemvenda.itvprocodigo=produto.prodcodigo and prodgrpcodigo=grupoproduto.grpcodigo
GROUP BY itvvencodigo
```

And finally, the SQL04 mentioned, performs an analysis to separate the products into categories, from the product table, sale item and product group in order to obtain trends from the grouped elements .

4. Results and discussions

As previously mentioned, the analysis was carried out on a drugstore basis with the objective of ascertaining some standards that may be relevant to the institution, assisting the team responsible for the layout of the items, in which it will be essential to change the places of these products, placing them close and visible to customers.

So, tests were developed that obtained satisfactory results, in which the company's administrators could have a notion of their sales flow, such as, for example, the products that had more outlets in February 2021.

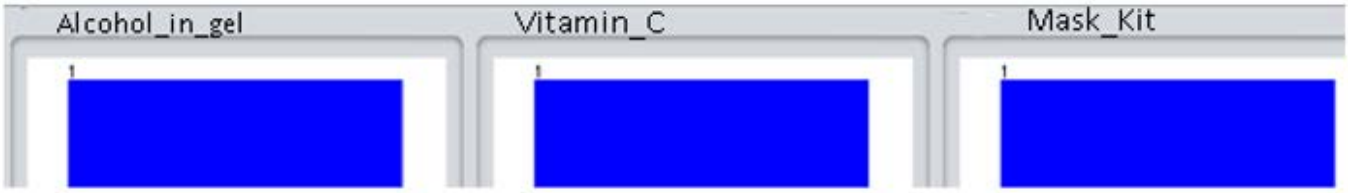

Figure 3: Best selling products on display at Weka
Source: Own authorship, (2021).

In figure 3, the three items that were most sold were presented, which are Gel alcohol, Vitamin C and Mask kit according to the analyzed data, from that the stock must be checked so that they always contain these products available for sale. sale. However, an analysis was also made of products that have a low output rate.

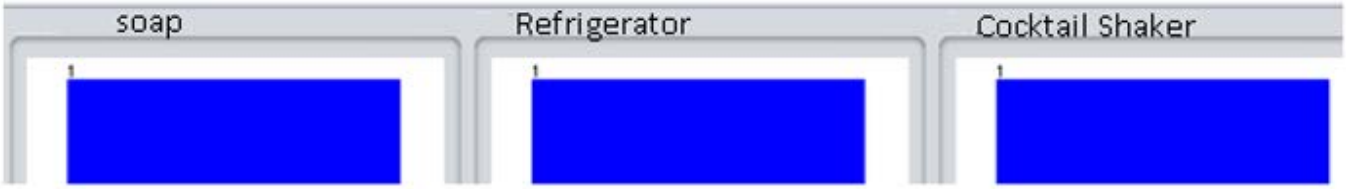

Figure 4: Less sold products exposed on Weka
Source: Own authorship, (2021).

Therefore, those products that were less sold according to Figure 4, which are soft drinks, soap and cocktail shakers, should be placed in more strategic places in view of customers, so that the percentage of sales will increase more and more.
There were also some queries that showed results that helped in the analysis of the sales items, for example, we analyzed the products and one of them is Dipirona.

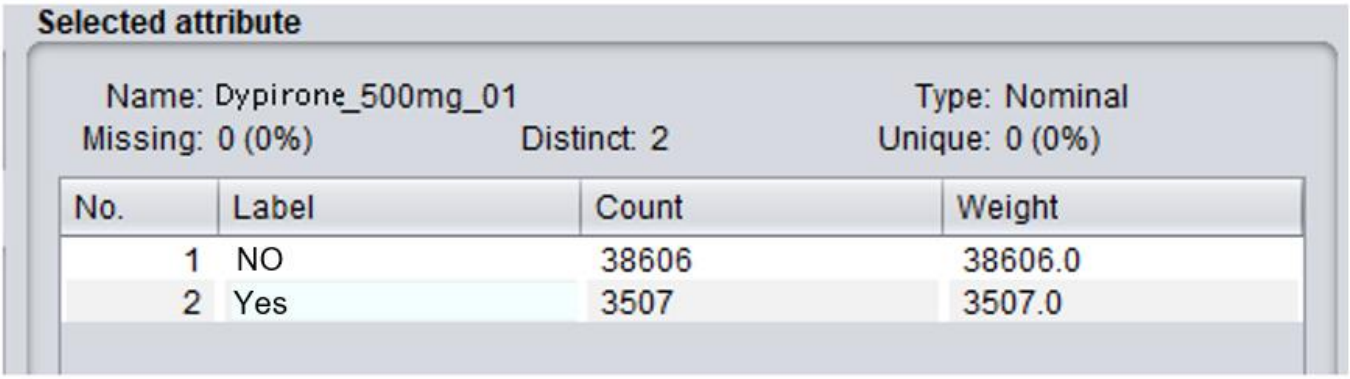

Figure 5: Sales on the product Dipirona exposed in Weka
Source: Own authorship, (2021).

As shown in figure 3, 3507 sales containing Dipirona were presented and 38606 did not have this item in the product outlets, from the analysis, it was observed that there was little sale, in which a planning must be made to increase the outflow of this product. product, such as a promotion. After this verification, we use the Apriori Algorithm to generate patterns:

1. Kit_de_máscara_facil_09=NAO Fralda_Huggies_M_04=SIM Epocler_13=NAO Umidificador_de_ar_15=NAO 2845 ==> Alcool_emgel_Giovana_Baby_02=NAO 2690 <conf:(0.95)> lift:(1.09) lev:(0.01) [227] conv:(2.45)
2. dvd_10=NAO Fralda_Huggies_M_04=SIM Epocler_13=NAO Umidificador_de_ar_15=NAO 2849 ==> Alcool_emgel_Giovana_Baby_02=NAO 2690 <conf:(0.94)> lift:(1.09) lev:(0.01) [224] conv:(2.4)
3. Perfume_Alfazema_08=NAO Fralda_Huggies_M_04=SIM Epocler_13=NAO Umidificador_de_ar_15=NAO 2850 ==> Alcool_emgel_Giovana_Baby_02=NAO 2690 <conf:(0.94)> lift:(1.09) lev:(0.01) [223] conv:(2.38)
4. Alcool_emgel_Giovana_Baby_02=SIM Kit_de_máscara_facil_09=NAO Epocler_13=NAO

Umidificador_de_ar_15=NAO 2753 ==> Fralda_Huggies_M_04=NAO 2598 <conf:(0.94)> lift:(1.09) lev:(0.01) [218] conv:(2.39)
5. Fralda_Huggies_M_04=SIM Epocler_13=NAO Umidificador_de_ar_15=NAO 3053 ==> Alcool_emgel_Giovana_Baby_02=NAO 2881 <conf:(0.94)> lift:(1.09)

According to the standards generated above, there are some standards, as if there are no sales containing products, such as item 1, which does not include the Mask Kit, Epocler and Air Humidifier, in one sale, there are 95% of Huggies Diapers being sold. To improve the output of these items, administrators must improve their planogram, improving promotions at strategic points.
In another experiment, we selected the product category groups, helping the customer to choose items from his purchase, a clearer way to visualize the products, not leaving him disoriented and needing help, such as the need to ask someone employee, the location of a particular object. And for this procedure, in knowing new patterns, we use the Apriori algorithm:

1. MEDICAMENTO_01=NAO HIGIENE_02=NAO HHOSPITALAR_03=NAO 12974 ==> COVINIENCIA_04=SIM 12974 <conf:(1)> lift:(1.37) lev:(0.08) [3535] conv:(3535.17)
2. MEDICAMENTO_01=NAO HHOSPITALAR_03=NAO 16201 ==> COVINIENCIA_04=SIM 14875 <conf:(0.92)> lift:(1.26) lev:(0.07) [3088] conv:(3.33)

For a better view of the customer, the products must be separated by categories according to the standard generated above, some standards were verified in which, if there is no purchase of medicine, then there is no hygiene or hospital sales, but it contains convenience products with 100% of trust. Another example is that if it does not contain medicines and hospital supplies, then there is convenience item output with 92% reliability. And some changes were also made to the settings to analyze the result.

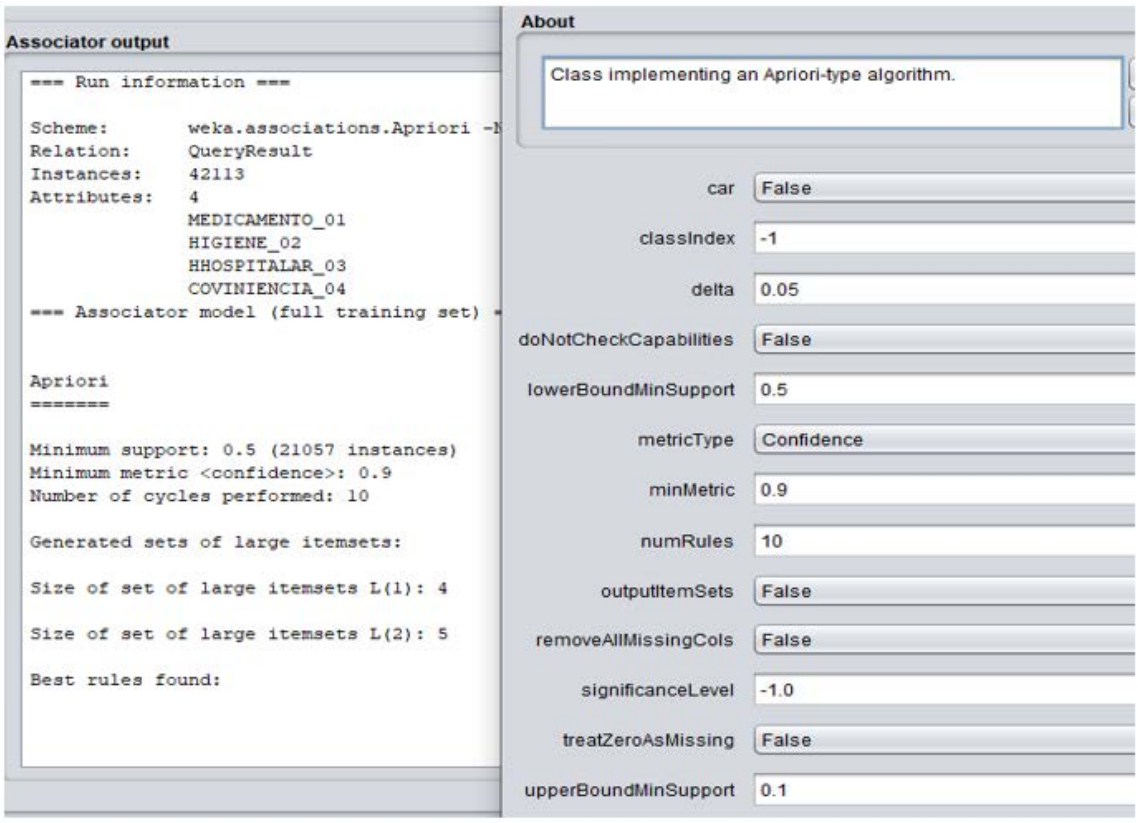

Figure 6: Configuration changes in product category defaults displayed on Weka
Source: Own authorship, (2021).

After executing the changes in the lower limit of the support for 0.5 and upper for 0.1, there was no pattern found according to the frequency of the data, in which there is confidence greater than 90% and support of 50%, according to analysis of 42113 instances.

Anyway, according to the analyzed data, the transactions that were carried out during purchases of the establishment, with their respective products, were soon able to carry out a study on the rules of associations and generate standards that assist in decision making, aiming to improve performance company commercial.

5. Conclusion

Commercial marketing aims to please the customer, assisting in their choices, promoting better services or products, encompassing a set of techniques to increase the company's economic performance.

Due to the aforementioned facts, to help in commercialization, in which there is a deficit in commercial marketing, one must invest in qualified professionals. And with the support of technology, in which it has several techniques to assist commercial performance, in which data mining was applied and the Apriori algorithm was used to analyze the profiles of customers and sales, in which patterns of agreements with the products were generated and sales item and product groups, also intensifying the grouping of items by categories through a better way to expose products at points of sale, improving the space of the drugstore and enhancing stock management.

From the SQL queries presented, in which it was observed satisfactory results for the company, assisting in decision making, in which the most sold products were verified, which are Alcohol gel, Vitamin C and

Mask kit, therefore to improve it sales logistics, more orders must be placed with suppliers to increase the volume in storage. And the least sold products are soft drinks, soap and cocktail shakers, according to the data collected, these should be placed at more strategic points to force more exits as well as the products that are sold grouped. According to Faria, Andrade and Facó (2017, p2) a well-known and discussed example is a case of Walmart in the United States, which used data mining tools in its sales and observed a great correlation between the sale of diapers and beer.

Finally, as a probable future work, it is possible to indicate the most detailed analysis of all days of the week, checking the items that leave daily, to create strategies such as promotions according to the customer's shopping trend, with the purpose of leverage sales

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EVALUATION OF ACCESS TO ORAL HEALTH AND THE NEED FOR TREATMENT IN ADOLESCENTS IN A FULL-TIME SCHOOL SYSTEM

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Abstract

This study evaluated the self-perception of adolescents' oral health and their oral conditions and the need for treatment in relation to dental caries. An epidemiological survey was carried out in the municipality of Belém, Pará, Brazil, in 2018. The sample consisted of 200 students, aged 11 to 16 years old, from a full-time public school. The data were collected through a questionnaire where their self-perception of their oral health was assessed and an intra-oral examination was carried out to assess oral health conditions in relation to dental caries, using the Dental Caries Index and need for treatment (ICDNT). The data analysis was based on the Chi-square test, and when the npq <5 restriction occurred, Fisher's exact test was applied. The comparison between quantitative variables was performed using the Student's t test. The average DMFT index was 3.57, with only 17% of the studied population free of caries. The carious

component was the one with the greatest significance (3.14) and the need for treatment with the highest prevalence was the restoration of one face (47.5%). A percentage of 88.5% of the adolescents evaluated answered that they did not take a toothbrush to school. The studied sample had a moderate prevalence of caries compared to the parameters recommended by the WHO, but above the standard obtained in the national survey carried out in 2010. Therefore, it is necessary to implement measures aimed at improving the quality of oral health of these adolescents and a full-time system would be a ideal for implementing good habits and routines for the adolescent's oral health.

Keywords: epidemiological research; dental caries; adolescent; oral health.

1. Introduction

Adolescence is a phase of biopsychosocial growth between childhood and adulthood, characterized by body changes and adaptations to new psychological and environmental structures. During this period, behaviors and lifestyles are being formed that may influence the pattern of morbidity and future health care [1,2].

The adolescent, therefore, shows himself to be more vulnerable to the affliction of certain diseases, since he is no longer benefited by the care and attention given to children nor does he enjoy the protection associated with the maturity of adulthood [3]. Oral diseases, such as dental caries and periodontal disease, have shown significant prevalence, with factors such as economic level, behaviors, age and care of the oral cavity, being pointed out as the main responsible ones [4]. These conditions can negatively impact self-esteem and the daily lives of individuals, causing pain, aesthetic changes and functional limitations [5,6].

Risk factors for chronic diseases can begin in adolescence, so this stage of life is considered fundamental in interventions and changes in habits and behavior. Oral hygiene is of great importance in preventing periodontal diseases and caries [7]. Procedures such as tooth brushing, control of sugar consumption, proper use of fluoride, flossing and periodic visits to the dentist are crucial in preventing and controlling these health problems [8,9].

The Ministry of Health (Brazil, 1997) considers that the school represents an educational and social environment conducive to working on knowledge and behavior changes. The World Health Organization (WHO) also recommends the training of multiplying adolescents, with a view to promoting quality of life and comprehensive health for adolescents [9].

The relationship between education and health sectors has many affinities in the field of public policies because they are based on the universalization of fundamental rights and, thus, favoring greater proximity to citizens in different corners of the country [10].

In 1996 was created the law n° 9394 of Basic Guidelines (LDB) of Education which concerns full-time education. In full-time education, it is possible to establish a wide range of diversified activities that, integrated into the school curriculum, enable a more complete training for human beings. In this sense, these activities are practices that include general knowledge, culture, the arts, health, sports and work [11]. Thus, the implementation of the full-time school by the State Department of Education (SEDUC), in Pará, is an offshoot of the national policy of basic education, foreseen in the National Education Plan. The

purpose of this action is to increase the student's effective time at school, in order to improve learning, strengthen social life and improve the quality of teaching.

One of the great challenges of dentistry is to work together with full-time schools, promoting information necessary for the development of habits to maintain health and prevent oral diseases in a change in attitude towards these diseases that are often considered inevitable in the phase of adolescence [12].

The objective of this study was to evaluate the adolescents' self-perception of oral health and to estimate the prevalence and treatment needs in relation to dental caries in students enrolled in a full-time elementary school, which currently works full time for around 200 students that enter the school at 7:30 am and leave at 5 pm, making two snacks and lunch during this period.

2. Methodology

This research was of a descriptive, observational, cross-sectional character. Initially, for the development of this study, 225 adolescents of both genders were invited, regularly enrolled in the academic year of 2018 in a full-time school in the metropolitan area of the municipality of Belém, Pará, Brazil. Being selected adolescents in the pre-established age range of 11 to 16 years, regularly enrolled, who were authorized by their parents to participate in the research through the Informed Consent Term, who answered a questionnaire and participated in the intra-oral examination. Those who did not express interest in participating in the study, incomplete questionnaires and adolescents who did not obtain parental authorization to participate in the study were excluded.

This study was carried out at E.E.E.F.M. Benjamin Constant, who currently works full time for elementary school, from August to October 2018, with prior authorization from the school and the Research and Ethics Committee (CAAE 37552114100005169). After signing the Informed Consent Form by parents and /or guardians ensuring the confidentiality of their identities and the use of information exclusively for research purposes, data collection was carried out.

3. Data collection and analysis procedure

Through a previously prepared questionnaire and clinical record, the adolescents' perception of oral health was evaluated, as well as their access to dental treatment. Then, oral health conditions were evaluated in relation to dental caries through an intraoral dental examination, following the criteria proposed by the World Health Organization (WHO, 1997) [12], which currently recommends the use of the Dental Condition Index and Need for treatment (ICDNT), which works as a modification of the traditional DMFT (decayed, missing and filled teeth). Subdivisions have been added for the filled item (with caries and without caries) and for lost items (for caries or other reasons), in addition to including treatment needs.

Data collection was carried out by 2 examiners and 2 annotators trained and previously calibrated. The clinical examination was performed with the aid of artificial light (portable torch), with the examiner and patients sitting face to face and with the aid of disposable wooden spatulas to remove the oral tissues and gauze for drying. All students who participated in the study received an oral hygiene kit (brush, cream and dental floss) before the exam for prior brushing. After the exam, topical fluoride was applied in disposable

trays. To evaluate the oral health characteristics of the sample of students, descriptive and inferential statistical methods were applied. Quantitative variables were presented by measures of central tendency and variation. Qualitative variables were presented by distribution of absolute and relative frequencies. The comparison between qualitative variables was performed using the Chi-square test, and when the npq <5 restriction occurred, Fisher's Exact test for independent samples was applied (Ayres et al, 2007, p.135). The comparison between the quantitative variables was performed by the Student's t test (to compare two independent samples) and by the Analysis of Variance (when there were more than two samples to be compared). The level of significance was set at alpha = 0.05 for rejection of the null hypothesis. Statistical processing was performed using GrafTable software version 2.0 and BioEstat version 5.3 [13].

4. Analysis of results

In the study carried out, a total of 200 individuals were examined, 42.5% (n = 85) of the male gender and 57.5% (n = 115) of the female gender. The age group ranged from 11 to 16 years old, the response rate was 95%. Of those examined 9% still had some deciduous element and when examined they were all healthy and without risk of caries. The DMFT index equal to zero was 17% (n = 34).

In the evaluation of the data from the self-perception questionnaire on oral health (Table 1), it was found that 88.5% of the adolescents had already gone to the dentist, and 11.5% answered that they had never been to the dentist. In the related item on where the consultation was held, there was a greater incidence of access to private services (39.5%), followed by care by public health system (SUS) (25.5%) and care through health plans (23.5%). Prevention (45%) was the reason for the greatest demand for dental care among adolescents. Toothache (19.5%) was in second place, followed by the need for orthodontic braces (14%) and other reasons (10%). Regarding self-perception of how they would classify their oral health status, 36.5% of the adolescents surveyed considered it excellent, 40.5% as good, 9.5% said they were regular, 2.5% rated it as poor and 11.5% declared it to be terrible. A considerable portion of the adolescents studied, 88.5% reported not bringing a toothbrush to school and 59.5% responded that they did not have an appropriate place for brushing.

Regarding the importance of having healthy teeth, 4.5% were responsible for aesthetics 52% for hygiene, 32.5% for health and 6% for chewing. When evaluating the self-perception questionnaire by age, we found that there were no statistically significant differences in relation to the questions.

Table 1: Self-perception of oral health among students enrolled in a full-time school in 2018 classified according to age, Belém, Pará, Brazil.

	Total Sample (n=200)	11 to 14 years (n=169)		15 to 16 years (n=31)		
	%	N	%	N	%	p-value
Gender						**0.7063**
Male	42,5	73	43.2	12	38.7	
Female	57,5	96	56.8	19	61.3	
Have you been to the dentist?						**0.7876**

Yes	**85,5**	**149**	88.2	**28**	90.3	
No	11,5	20	11.8	3	9.7	
Where was the attendance?		(n=149)		(n=28)		**0.0338***
Public health system	25,5	42	28.2	9	32.1	
Particular	39,5	62	41.6	17	60.8	
Health plan	23,5	45	30.2	2	7.1	
What was the reason for the attendance?		(n=149)		(n=28)		**0.0996**
Prevention	45	73	49	17	60.7	
Toothache	10	37	24.8	2	7.1	
Use of orthodontic appliance	14	21	14.1	7	25	
Other reason	10	18	12.1	2	7.1	
How is your oral health?						**<0.0001***
Great	35,5	70	41.4	3	9.7	
Good	40,5	68	40.2	13	41.9	
Regular	9,5	7	4.1	12	38.7	
Bad	2,5	2	1.2	3	9.7	
Lousy	11,5	22	13.0	0	0.0	
Do you bring toothbrush to school?						**<0.0001***
Yes	14,5	3	1.8	20	64.5	
No	85,5	166	98.2	11	35.5	
Is there a suitable place for brushing?						**0.1492**
Yes	40,5	64	37.9	17	54.8	
No	59,5	105	62.1	14	45.2	
Importance of maintainig oral health						**0.3255**
Aesthetics	4,5	6	3.6	3	9.7	
Hygien	52	87	51.5	15	48.4	
Health	32,5	69	40.8	10	32.3	
Chewing	6	7	4.1	1	3.2	

*Chi-square of independance

Table 2 shows the conditions of dental caries by dividing the sample by age. In the 11-year-old age group, the DMFT corresponded to 2.53, followed by 3.0 for the age of 12 years, 4.23 in the 13-year-old adolescents, 3.72 at the age of 14. For 15-year-old students, DMFT was equivalent to 2.82, on the other hand, the index in 16-year-old students was the highest 5.14. Note the progression of the DMFT according to age. The overall average for DMFT was 3.57.

Table 2: Number of schoolchildren examined (n), average DMFT and its components according to age. School in the municipality of Belém, Pará, Brazil, 2018.

Age (years)	N	Decayed	Lost	Filled	DMFT
11	19	2.26	0.00	0.26	2.53
12	55	2.67	0.11	0.22	3.00
13	47	3.49	0.49	0.26	4.23
14	46	3.30	0.15	0.26	3.72
15	17	2.76	0.00	0.06	2.82
16	14	4.36	0.21	0.57	5.14
Total	**198**	**3.14**	**0.16**	**0.27**	**3.57**

DMFT-D = index of decayed, lost and restored teeth per individual.

* p-value <0.0001, ANOVA with Tukey post-test

Regarding the need for treatment for dental caries (Table 3), there was a need for dental restoration of one face in 47.5% of those evaluated. Secondly, the application of sealant (24.7%), followed by restoration of two or more faces (13.6%), pulp therapy (3%) and extraction (1%). When separating the treatment needs in relation to the age group, we observed that there were statistically significant differences in relation to the need for restoration of a face and extraction.

Table 3: Percentage of treatment needs of students classified according to age: 11 to 14 years old (n = 169) and 15 to 16 years old (n = 31). School in the municipality of Belém, Pará, Brazil, 2018.

	11 to 14 yeas		15 to 16 years			Total	
	%	CI95%	%	CI95%	p-value	%	CI 95%
DMFT	3.49	2.7 a 4.4	3.87	1.3 a 5.2	0.9280	3.55	2.4 a 4.6
Dental restoration one face	45.9	43.8 a 48.5	69.6	65.9 a 76.1	0.0111*	47.5	44.4 a 50.6
Dental restoration two faces	13.5	12.0 a 15.2	17.4	12.0 a 20.2	0.7102	13.6	11.5 a 15.7
Pulp therapy	2.9	---	4.3	1.1 a 5.2	0.9361	3.0	---
Sealant	25.9	23.9 a 28.1	21.7	17.9 a 27.2	0.6850	24.7	22.0 a 27.4
Tooth extraction	0.6	---	4.3	1.3 a 5.2	<0.001*	1.0	---

* p-value <0.0001, ANOVA with Tukey post-test

5. Discussion

Education is at the heart of any health program. Their results are significant when they manage to promote positive changes in people's behavior. The implementation of oral health education programs in schools provides children with knowledge about effective ways to prevent oral diseases. Motivation is also an indispensable requirement for learning. It is a personal, internal process that determines the direction

and intensity of human behavior. Learning is only accomplished by unleashing motivating forces. It is noteworthy that an ideal and appropriate place for the introduction and development of oral health education is found in primary schools [14].

People's attitude about their health, particularly oral health, is shaped by their personal experiences. These will act as determinants of behaviors and perceptions, fundamental in the adoption of oral health habits and in the development of a pattern of behavior related to them. It is known that the needs of the population, as well as disease / health conditions are verified through epidemiological surveys [15]. However, studies show that people are able to perceive their oral condition with certain precision, using different criteria than professionals. For individuals, symptoms and functional and social problems resulting from oral diseases are important. Various instruments available in the literature can be applied to obtain subjective data on oral health [16]. They are questionnaires with the purpose of unveiling the individual's perception of how oral health interferes in their daily lives and in their quality of life. This new study model is fundamental for oral health education, as it is able to develop in people a critical awareness of the real causes of their problems [17]. Although oral health education is gradually being introduced into the lives of Brazilians, many do not have access to places where it can be transmitted or there is simply no opportunity, due to the lack of means of disseminating health knowledge in their communities [18].

An multicentric study evaluate the potential support of the school environment for the promotion of oral health and associated factors in Brazilian capitals. Data from 1,339 public and private schools in the 27 Brazilian capitals were obtained from the National School Health Survey (PeNSE). The analysis resulted in a model with three dimensions: D1. intra-school aspects (sale of food with added sugar in the canteen and health promotion actions), D2. aspects of the school environment (selling food with added sugar at alternative points) and D3. prohibitive policies at school (prohibition of alcohol and tobacco consumption). Of the total schools studied, 51.2% had a more favorable environment for oral health. In the capitals, this percentage varied from 36.6% in Rio Branco to 80.4% in Florianópolis. Among Brazilian regions, it varied from 45.5% in the North to 67.6% in the South [19].

In the present study, most adolescents reported having gone to the dentist (85%), this percentage is lower than the data found in other articles. In the study presented by Silveira et al. 2009, in Montes Claros/ MG [20] it was found that 93.9% of the interviewees reported having gone to the dentist. In another study carried out in the city of São Paulo, it was observed that 92.1% of the adolescents had already used the dental service. Therefore, in the comparison of the data, we realized that although the sample of the city of Belém was below the average of other cities, it still has a percentage above the last survey on oral health conditions of the Brazilian population SB- Brazil 2010 [21] in which 86% of Brazilian adolescents stated that they had used dental services at least once.

A study in Sergipe/Aracajú [22], showed that 40% of respondents used health insurance, 23% private and 30% public service. Analyzing the data from the present study, there was a higher prevalence of private care (39.5%), due to socioeconomic factors and the easy access to popular clinics, demonstrating the inefficiency of SUS in the provision of oral health to the low-income population. The main reason for the last visit to the dentist reported by the adolescents was for prevention, with 45%, in line with the results found in other Brazilian studies [15,20]. In this reaserch, it was found that 40.5% of those investigated rated their oral health as good. Similar frequencies were found in a study carried out in Pelotas-RS [15], who

report a high percentage regarding self-perception of oral health as good / very good, corresponding to a total of 68.8% of the interviewed. In the study by Silveira et al. 2008 [20] it was also found that 65.6% of the adolescents rated their oral health as good or excellent.

As the Benjamin Constant school did not have epidemiological data previously collected, the results obtained in this study, in addition to providing relevant information on the prevalence and severity of dental caries, identified the main treatment needs and contributed with motivational lectures on the importance of oral hygiene. It was observed in this study that the prevalence of dental caries increased with age, and the values found among 12-year-old adolescents (DMFT-3 = 3) can be classified as average using the WHO table for the classification of DMFT- Give to 12 nos. This value was above the national value found in the last survey carried out at SB Brasil 2010 (CPO-D = 2.7 to 12 years old) and slightly below the value found specifically in the northern region (CPO-D = 3.06). However, the value found in our findings is well above that recommended by WHO for the year 2010 (DMFT = or less than 1 to 12 years old) [21].

In a work carried out in Rio Preto da Eva in the Amazon [23], the average DMFT in both rural and urban areas was evaluate and the results were 3.6 and 3.9 respectively. In the present study, the average DMFT was 3.57, in line with data from studies carried out in other regions of the country, such as the South and Southeast. A study carried out in Lages Santa Catarina (caries free 55%) 2010 [24] showed a DMFT = 1.02 and in the same year a study carried out in the state of São Paulo (caries free 53%) the DMFT index = 1.37. In the data found in our research, the DMFT was superior to that found in other articles in the south and southeast regions. We attribute this value to the index of decayed components, at all ages, which was more significant than the lost and filled components, which may be revealing a general situation of lack of access to assistance services for this population.

Regarding the needs of dental treatment, the results showed a high concentration in easy-to-solve and low-cost restorative treatments that can be performed in Primary Care Units in Oral Health, by general practitioners. Need for more complex treatment such as endodontics and prosthetic treatment, were in the minority. According to a research in Montes Claros - Minas Gerais [25] the percentage of pulp treatment + restoration needs was 9.9% and extraction 5.6%. These numbers are higher than the findings in the present study.

In Itirapina - São Paulo, a study showed the need for restorative treatment of a surface was the most prevalent (74.2%)[26], as well as in Montes claros – Minas Gerais [25], demonstrated that 50, 3% of adolescents needed restorative treatment on one face, so our result is equivalent to the treatment needs of other regions of the country.

In relation to the high rate of application of sealant (24.7%), we assume that due to the high rate of decayed components, the other elements are at risk of caries, so the indication of sealant would be to preserve the integrity of the others elements that are still without caries or are in the initial stages. However, it is worth mentioning that although the vast majority of students consider their oral health to be excellent or good, only 17% of them were free of caries and without the need for treatment.

School works as an extra-family environment that allows reinforcing social responses learned at home, representing new ones and even restricting or excluding incorrect habits. An integrative action between education and dentistry, introducing oral health content into the curriculum of early childhood and elementary education through programs, has justification: to teach children and adolescents to teach oral

health. As long as it is based on evidence and well trained, the teacher can be a multiplying agent in this context [27,28].

6. Conclusions

In view of the analysis and discussion of the results obtained in the present study, we can conclude that the target population of the study has moderate values in relation to the DMFT indexes and the need for restorative treatment of a face. The percentage of adolescents who do not take a toothbrush to school is quite significant for the 11 to 14 years old age group and the majority reported not having an appropriate place to brush at school. These poor brushing practices are probably one of the factors attributed to the high rate of caries observed. Therefore, it is necessary to implement measures aimed at improving the quality of oral health for these adolescents. We suggest the elaboration of a project for the construction of a brush track in the school together with measures of preventive and educational actions such as cycles of lectures to reinforce and motivate hygiene for these adolescents. Despite the recent advances, the results of this study indicate that there is still a need to increase the coverage of public dental services for adolescents, as well as point to the necessary revision of public policies regarding the availability of health promotion actions, including health education for adolescents. Teenagers and the full-time system would be a ideal for implementing good habits and routines for the adolescent's oral health.

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Comparative analysis of sustainability assessment methods in agroecosystems

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ABSTRACT

The aim of this work was to compare and analyze three different methods of the sustainability evaluation in agricultural systems, such as the Indicateurs de Durabilité des Exploitations Agricoles (IDEA), the weighted Assessment of environmental impact of New Rural activities (APOIA Novo-Rural), and the indicators of sustainability in Agroecosystem (ISA). Those methods were compared by two criteria. The first one relates to the distribution of sustainability indicators into categories (Endogenous System Operation, Endogenous Resources, Exogenous Systems Operation, and Exogenous Resources) and elements (technical, socioeconomic, natural and cultural resources). The second one involves the conceptual approaches of each method towards the concept of sustainability, objective and target audience, adoption of the systemic approach, level of stakeholder's participation, level of adequacy, and method flexibility in different realities. The indicators set of each method, although quantitatively different, consider the diversity of elements that involve the agricultural systems. The IDEA method concentrates its indicators on the Endogenous System Operation category, while the APOIA Novo-Rural and the ISA methods concentrate their indicators on the Endogenous Resources category. The IDEA method directs the assessment to the awareness of the environmental processes that surround the agricultural activity in the property. On the other hand, in the APOIA Novo-Rural and the ISA methods, the reflective practice is fostered from impacts on the environment, and can be improved by extension actions. The main difference presented among those methods is the integrative evaluation of the indicators as well as trade-offs involved.

Keywords: APOIA Novo-Rural methods. Agricultural sustainability. IDEA methods. Indicators of sustainability. ISA methods.

1. Introduction

The term sustainability assessment designates the set of interests mediated by the sustainable development concept, whose main definition implies the ability to use natural resources by current generations without compromising future generations (CMMAD, 1991). Sustainability assessment is a method widely discussed and propagated as an effective action to stimulate the development of programs and policies that guide the promotion of sustainable agricultural systems (Binder et al., 2010).

The use of methods for assessing sustainability in agroecosystems helps to define and analyze the environmental performance of production systems, based on the structuring and data interpretation, which reflect the experiences of farmers and the type of relationship they have with their system. Nevertheless, the assessment of sustainability in agroecosystems is one of the most complex types of methodology, not only because agriculture involves multidisciplinary aspects (environmental, economic and social), but also due to the variety of cultural and functional elements that surround it (Sala et al., 2015; Binder et al., 2010; Binder and Wiek, 2006).

Among the innumerable initiatives available to assess sustainability in agricultural systems, the following stand out: Sustainability Indicators of Agricultural Explorations – IDEA (Vilain, 2008), developed by French researchers in order to offer a diagnosis of agro-environmental, socio-territorial and economic sustainability at the rural property level; the Weighted Assessment of Environmental Impact of New Rural Activities – APOIA Novo-Rural (Rodrigues and Campanhola, 2009) and Indicators of Sustainability in Agroecosystem – ISA (Ferreira et al., 2012), both developed in Brazil.

The sustainability assessment methods vary according to the assessment objectives set by its developers, and may present indicators with common or even divergent characteristics. Given this and the different types of existing agro-ecosystems, the choice of the evaluation method must be appropriate to the objective and to the peculiarities of the local reality to be studied, with easy validation and interpretation.

Thus, in order to compare three methods of assessing sustainability at the rural property level: IDEA, APOIA Novo-Rural and ISA, the present study was developed, aiming to characterize the components of each method analyzed.

2. Material and methods

To compare the methods IDEA, APOIA Novo-Rural and ISA, two methodological criteria were used: The first was the distribution of sustainability indicators in categories and elements proposed by Camino and Müller (1993) and; the second makes use of Binder's conceptual approaches, according to Feola and Steinberger (2010).

In the first criterion, the sustainability indicators were separated and distributed into assessment categories and elements. The categories and elements are important aspects of the sustainability analysis in agroecosystems, as they represent the outline of how sustainability indicators were conceived and organized (Camino and Müller, 1993). By this criterion, there are four categories: endogenous system operation; endogenous resources; exogenous system operation; and exogenous resources.

The endogenous system operation refers to the activities carried out within the analyzed system and shows whether the management of the agroecosystem is compatible with the sustainability guidelines.

Endogenous resources correspond to the structural resource base that belongs to the analyzed system, with indicators that show whether this system negatively impacts or improves the agroecosystem resource base. The exogenous systems operation is characterized by functional activities external to the agroecosystem, but which maintains close relationships, affecting and being affected by the system (Daniel, 2000). Exogenous resources correspond to resources external to agroecosystems. Each category is subdivided into elements. These elements are related to the technical operations of agricultural activities execution and to the resources used (water, soil, air, climate, vegetation, etc.), not only of the system under evaluation, but also of its surroundings.

Then, the percentage of indicators present in each category was calculated. Some sustainability indicators, adopted in the evaluated methods, are composed of different measurement parameters, so that the result expressed by that indicator corresponds to the sum of several parameters. For these cases, the parameters were disaggregated, being considered as separate indicators and thus it distributed within each category. This technique is made feasible to identify with greater reliability the elements of greatest concern in the methods. The indicators obtained by mathematical expressions, such as proportion (cultivated area / total area, for example), were maintained as they were.

In the second criterion, the methods IDEA, APOIA Novo-Rural and ISA were compared by their conceptual execution way. For this, the approaches adopted by Binder et al. (2010) were used sustainability concept; objective and target audience; systemic approach adoption; stakeholder participation level and adequacy level. Through this approach, the sustainability concept refers to the sustainability understanding that is reflected in the indicators and it is determined in the results interpreting process. The objective and target audience refer to the different directions listed by the methods, which may be more or less important in relation to an aspect depending on the method end users or target audience (farmers, agricultural technicians, public or private intuitions). The systemic approach adoption deals with the complexity interpretation involved in the agricultural system, which allows it to analyze the economic, social and environmental aspects, as well as its trade-offs. The stakeholder participation level refers to teams interested in the agroecosystem evaluating process (usually represented by farmers who are involved in the evaluation process) for the purpose of implementing or monitoring sustainable agriculture. Finally, the adequacy level refers to the method capacity to adapt to different realities, which may vary according to the analysis spatial scale (local, regional, national or international), to lead to different interpretations or to mask the results. The Binder et al. (2010) approaches aims to outline the conceptual basis of each method, its development process and evaluation process execution, in order to highlight the main differences between them (Cândido et al., 2015).

Thus, sustainability indicators and their conceptual approaches for identifying the objectives, weaknesses and sensitivity presented by each method were evaluated.

The IDEA, APOIA Novo-Rural and ISA methods were applied simultaneously in Rural Land Reform Settlements in the municipality of Simão Dias, Sergipe, Brazil, with two Settlements being selected: “Oito de Outubro” (10° 39' 85” S and 37° 44' 59" O) and “27 de Outubro” (10º 39' 03” S and 37º 42' 52” O). Both settlements produce corn grain (*Zea mays*) in rainfed systems, managed by family producers, mostly from the movement/group “Landless”. For ISA application in “Oito de Outubro” and

"27 de Outubro" rural settlements, the seven sub-indices with 22 indicators were considered, except for the food security indicator around the homes due to collecting parameters impossibility (Silva, 2018).

3. Results and discussion

3.1 Distribution of IDEA, APOIA Novo-Rural and ISA sustainability indicators by Categories and elements

The indicators distribution by categories and elements is shown in Table 1. The IDEA method concentrates its indicators in the endogenous system operation category (81%), while in APOIA Novo-Rural and ISA, most indicators are fit into the endogenous resources category (66.1% and 59.5%, respectively). This result shows the different directions given by each method to the sustainability concept, even though all of them have the rural establishment as a spatial scale level.

In the endogenous resources category, the IDEA has 9.5% of its indicators in the elements flora, landscape structure and cultural resources, focusing on the presence and extent of natural vegetation on the property, the presence of water sources (springs or rivers) and the enhancement of historic buildings, as environmental sustainability analysis. IDEA does not bring data obtained from soil and water analyzes to the evaluation process, which limits, in technical terms, the environmental impacts measurement on a time scale. On the contrary, APOIA Novo-Rural and ISA seek to evaluate soil productive capacity data through the soil chemical analysis and the surface and underground water quality. For both methods, analyzes of soil and water physical-chemical properties are adopted, according to current rules, procedures and technical limits in Brazil, confirming them as tools in the environmental management of agricultural properties.

Table 1. Distribution of IDEA, APOIA Novo-Rural and ISA sustainability indicators by Categories and elements.

Category	Element	Indicators Number		
		IDEA	APOIA	ISA
Endogenous resources	Soil	-	10	10*
	Water	-	14	8**
	Flora	2	3	3
	Fauna	-	2	-
	Air	-	7	-
	Landscape structure and	1	4	1
	Cultural resources	1	1	-
	Total (number; %)	**4 (9; 5%)**	**41 (66; 1%)**	**22 (59; 5%)**
Endogenous system operation	Management and technical performance	9	-	3
	Management and socioeconomic performance	25	19	10
	Total (number; %)	**34 (81; 0%)**	**19 (30; 7%)**	**13 (35; 15)**
Exogenous resources	Soil	-	-	-
	Water	-	-	-

	Flora	-	-	-
	Fauna	-	-	-
	Air	-	-	-
	Landscape structure and	-	-	-
	Cultural resources	1	1	1
	Total (number; %)	**1 (2; 4%)**	**1 (1; 6%)**	**1 (2; 7%)**
Exogenous system operation	Management and technical performance	-	-	-
	Management and socioeconomic performance	3	1	1
	Total (number; %)	**3 (7; 1%)**	**1 (1; 6%)**	**1 (2; 7%)**
Grand total of indicators		**42**	**62**	**37*** **

* Soil fertility indicator was analyzed by its respective 10 parameters; ** The Surface and underground water quality indicator were analyzed respectively by their 4 and 3 respective parameters; *** Total number of indicators considered for calculating the percentage. Adapted from Vilain (2008), Rodrigues and Campanhola (2009) and Ferreira et al. (2012).

It is worth mentioning that, in agricultural systems, the monitoring of soil physical, chemical and biological quality, as well as the characterization and monitoring of lakes, rivers and water sources must be part of the farmer's planning and consequently of a sustainability assessment program. Soil analysis is an important tool for productivity, profitability and the environment, which combined with other information, such as land use and occupation and climate characteristics, bring the farmer a better ability to manage the agroecosystem (IPF, 1998). In addition, Brazil has its own classification regarding the support capacity of land use (Lepsch et al., 1991), which can provide rational planning for it and guarantee the preservation of several endogenous resources.

In the APOIA Novo-Rural and ISA methods, soil analyzes are basically covered by the same chemical data, which evaluate the soil productive capacity through chemical fertility parameters. The same criterion is used for the water element, however the APOIA method presents the larger indicators structure for assessing surface water quality in relation to ISA, such as the dissolved oxygen, fecal coliforms, BOD5, pH, nitrate, phosphate, solids parameters totals, chlorophyll, conductivity and water visual pollution, as well as for groundwater quality, such as fecal coliforms, nitrate and conductivity. In the evaluation of the water quality, the methods only have in common the parameters of pH, fecal coliforms, Turbidity and Nitrate.

APOIA Novo-Rural was the only method to present indicators related to the Air element, with 6 indicators aimed at sensory evaluation of atmospheric pollution (Particles in suspension/smoke, Odor, Noise, Carbon oxides, Sulfur oxides, Nitrogen oxides and Hydrocarbons). In IDEA, atmospheric pollution is indirectly assessed in the Energy Dependency indicator, which assumes the use or not of CO_2-generating energy sources.

The indicators related to the Fauna element in the Endogenous resources category were also prioritized only by APOIA Novo-Rural. The method evaluated the fauna corridors presence and existence of species threatened with extinction, especially after agricultural activity implementation. The fauna analysis has crucial importance in the assessing sustainability process in agricultural systems, since the use of pesticides associated with monocultures extensive areas can destroy natural habitats threatening the local

fauna and its trophic chains. This fact highlights that, among the evaluated methods, APOIA presents a broader view of environmental systems, giving it greater importance for defining what would or would not be sustainable.

The APOIA-Novo Rural method directs the assessment process towards the environmental impact caused by agricultural activities, adopting the situation before and after the implementation of rural activity as a period (Sanchez and Matos, 2012). APOIA-Novo Rural translates sustainability from the causes and consequences that agriculture and livestock have on natural resources and on the flora and fauna biodiversity. The ISA method also directs the indicators for assessing the environmental impact, and highlights the importance of sustainable agriculture in an assessment process that emphasizes the consequences agricultural activity execution on the soil and water natural resources. ISA focuses on the formation of more sustainable agricultural systems (Ferreira et al., 2012).

On the other hand, the sustainability assessment by the IDEA method is based on technical and socioeconomic conditions of agriculture and livestock, and how these are being developed on the rural property. Its indicators, concentrated on the endogenous system operation (81%), direct the main focus of the IDEA method towards practical agricultural actions that may or may not lead to environmental impact, consisting of its most evident and differential characteristic in relation to the other evaluated methods. The endogenous system operation category in the APOIA-Novo Rural method is covered by 30.7% of the method indicators, listed in the element Management and socioeconomic performance, which represents a concern in the evaluation process with the socioeconomic sustainability of rural properties. However, APOIA-Novo Rural fails to highlight aspects related to Management and Technical Performance as the inputs and energy source. In the ISA method, the endogenous system operation category concentrates 35.1% of the indicators, directing its evaluation to both elements (Management and Technical Performance and Management and Socioeconomic Performance) of this category.

Regarding the Exogenous Resources category, each method (IDEA, APOIA Novo-Rural and ISA) had only one indicator could be classified as relevant to this category. The indicators Social involvement of IDEA, Institutional relationship at APOIA Novo-Rural and Basic services available at ISA. These indicators represent the element Cultural resources and assess the social relationship that the producer and his establishment have with the surrounding communities and with access to technical and social assistance. As the evaluation spatial focus of the three methods is the rural property, in none of them there were indicators related to the Soil, Water and Air elements. That could be classified as relevant to the category Exogenous Resources, since the environmental effects external to the rural establishment limits are part of a larger spatial scale (regional, for example) not covered by the evaluated methods.

In the exogenous system operation category, the IDEA method has, in the element Management and socioeconomic income, the indicators: sales mechanism, sensitivity to quotas and subsidies and space accessibility, which corresponds to 7.1% of the indicators. These indicators assess, respectively, products commercialization, credit availability and infrastructure of access roads to the establishment, which are fundamental to the good activity economic performance and consequently to its sustainability. In this category, the APOIA Novo-Rural method is represented by the indicator marketing condition (1.6%) and the ISA, by the Conservation State of internal and external roads (2.7%). In this sense, the three methods

direct the sustainability assessment also to operational aspects external to the rural property, whose quality greatly influences the quality of technical operations and management carried out by the farmer.

3.2 Conceptual approach to the sustainability assessment methods (IDEA, APOIA Novo-Rural and ISA) in agricultural systems

Table 2 presents a simplified comparison of the approaches related to the operationalization of each evaluation method.

TABLE 2. Comparison between the sustainability indicators methods of Agricultural Holdings (IDEA), Weighted Assessment of Environmental Impact of Novo Rural Activities (APOIA Novo-Rural) and Agroecosystem Sustainability Indicators (ISA)

Analysis criteria	IDEA	APOIA Novo-Rural	ISA
Sustainability concept	Predefined concept based on environmental reproducibility, habitability and economic viability aspects	Pre-defined concept aimed at assessing the environmental impacts of Novo Rural emerging activities	Predefined concept and guided by the social, economic and environmental dimensions for a transition process
Objectives and target audience	Mediate through self-assessment a process of raising awareness among farmers for sustainable agriculture	Advising producers and decision makers on the environmental impacts assessment	Mediate through the management tool a transition process to a more sustainable agro-ecosystem
Systemic approach	It Adopts three sustainability scales (Agroecological, Territorial and Economic Partner) with no interactions and no trade-off between them	Considers the interaction between the indicators and between the five dimensions with trade-offs between them	It Adopts the socioeconomic and environmental dimensions considering the interactions between the indicators with trade-offs between them
Stakeholder participation	Farmer, teacher, student and technicians, with evaluation procedures pre-defined by specialists (top-down approach)	Farmer, manager or technical consultant. With assessment procedure with top-down and botton-up approach	Farmer, external manager or technical consultant. Evaluation procedure with top-down and botton-up approach.
Adequacy	Rigid and standardized structure that requires adaptation to different contexts	Rigid, computerized and applicable structure to any activity in the Brazilian rural environment	Rigid, computerized and sensible structure to different agroecosystems

Adapted from Vilain (2008), Rodrigues and Campanhola (2009), Ferreira et al. (2012) and Cândido et al. (2015).

3.2.1 Sustainability concept

The three methods are basing on a sustainability-predefined concept. Although all methods have the guidelines proposed by Brundtland report (CMMAD, 1991) as a common reference point, the definitions adopted follow specific terms according to each method focus.

In the IDEA method, the normative approach (Sanchez and Matos, 2012) guides the sustainability concept, that is, hierarchical models bases the information. In this approach, the indicators are scored in priority order, observing the agricultural systems multidimensionality (environmental, social and economic). Additionally, these sustainability dimensions or scales are respectively based on three main aspects: Environmental reproducibility, Habitability and Viability. These aspects mean that a rural establishment must guarantee the environmental quality of natural resources, be habitable for the farmer and his family and be economically viable (Zahm et al., 2008).

In APOIA Novo-Rural, a systemic approach guides the sustainability concept. Here, the economic and social system is interpreted as an integral part of the ecosystem and the sustainability indicators are derived from critical points identified in agro-ecosystems (Sanchez and Matos, 2012), which generate or may generate some type of environmental impact. Thus, agro-ecosystem performance indicators that address environmental impacts and pressures on the environment and the possible improvements made in the agro-ecosystem form APOIA Novo-Rural (Rodrigues and Campanhola, 2003).

In ISA, a set of indicators that aim to direct agro-ecosystems to the transition process to a more sustainable standard support the sustainability concept (Ferreira et al., 2012). The tool has a normative character in which the social, economic and environmental dimensions address sustainability. These dimensions support elements related to planning, management, conservation, training, access and diversification.

The three methods have in common the combination of sustainability basic principles. In IDEA and ISA, these principles are multidimensional, while in APOIA Novo-Rural, these principles are multifunctional. In multidimensional principles, sustainability is subdivided and analyzed by dimensions (social, economic, environmental, cultural, political, among others) observing its scope and, therefore, the functions performed by each dimension. In the multifunctional principles, sustainability is analyzed from the main functions of the agricultural system, such as food security, biodiversity and natural resources conservation, landscape maintenance, socioeconomic and cultural quality.

The indicators matrix formulated by IDEA brings a well-defined and rigid concept of sustainability (Cândido et al., 2015). This matrix is presented in a scoring system that highlights the presence and trend of agroecosystem aspects associated with sustainability. The measured indicators are added in nine components and three dimensions (Agroecological, Territorial and Economic partner) and each dimension can reach a maximum of 100 points. The final sustainability of the evaluated property will be equal to the lowest score of the three dimensions, that is, the sustainability of a system will be equal to the lowest numerical score obtained by one of its dimensions (Binder et al., 2010).

The APOIA Novo-Rural and ISA matrix follows an even greater principle of sustainability concept definition and rigidity, by proposing a general environmental impact assessment from a standard or baseline

(benchmark). The scoring system is standardized between 0 and 1 and the system sustainability degree is given according to the reference value (0.7); if below, barely sustainable, if above the line, sustainable. However, Moraes et al. (2012) highlight that the existence of a single reference line in APOIA Novo-Rural limits the environmental impact interpretation, as it stipulates a pre-defined environmental standard, which may not correspond to the minimum expected situation by the rural establishment. The result obtained by ISA follows the same approach mentioned above.

3.2.2 Objectives and target audience (End users)

Regarding the objectives, IDEA was developed to be a teaching tool for the implementation and awareness of the sustainability concept in farms, with a view to reducing the impacts caused by agriculture and livestock itself (Briquel et al., 2001). In this sense, the IDEA method is aimed at teachers and rural extension workers whose target audience is farmers.

APOIA Novo-Rural is a management tool for various rural activities (Rodrigues and Campanhola, 2003). The method is aimed at advising producers and decision makers on the environmental impacts assessment at the farm level, with the target audience of farmers themselves. It developed ISA as a tool for measuring economic, social and environmental performance on the rural establishment's scale (Ferreira et al., 2012). Thus, its objective is to assist decision-making by those responsible for productive activities for a transition process to a more sustainable agro-ecosystem, with the target audience of farmers.

The three methods assess sustainability on a local scale and target rural farmers themselves. Questionnaires addressed to farmers and field observation generate the information. IDEA presents a didactic / pedagogical characteristic of application that allows the farmer/manager himself to carry out the evaluation process. APOIA Novo-Rural and ISA, despite being easy to apply, need technical support in order to avoid the subjectivity in the information collection, mainly regarding the changes that occurred after introduction of the new activity (Rodrigues and Campanhola, 2003).

The analysis and interpretation of the sustainability assessment in the three methods are easy to represent. The quantitative indicators use allows the use of a radar type graph and histograms. The results aim to help farmers to reflect on their practices, giving guidance as to the need for rural property improvements, so it can be compared between properties or between properties groups. In addition, ISA generates a summary table for evaluating rural property, which can be used as a basis for generating a general report of the evaluated establishments set (Ferreira et al., 2012). This report can contribute in a general way to the socioeconomic and environmental interpretation of the agricultural system in a given location.

3.2.3 Adoption of the systemic approach

The environmental systems understanding encompasses aspects related to human activities and how these activities cause disruption or impact to natural systems. The systemic approach is opposed to reductionism and it is used as a support notion to designate the whole set of relationships between parts that form a whole (Morin, 2005). From the systemic approach perspective, the sustainability assessment of agricultural systems encompasses the action of each element involved in production, such as those formed by technical and environmental resources.

In the IDEA execution, the elements are analyzed on independent and non-cumulative scales (Vilain, 2008), which separates it from the systemic approach integrative action. The indicators are grouped together forming indices within each component, which, in turn, are aggregated to generate the index corresponding to each sustainability scale. The values of each scale are analyzed individually without being added, so that there is no compensation from one scale over the other, which could mask the reality. However, although there is no generation of a sustainability index (value), the results of each scale can be analyzed in an integrated manner.

In ISA, its indicators exhibit systemic approach characteristics, despite being a normative method. The method seeks to cover several aspects that lead to the sustainable agriculture understanding. The three dimensions (Economic, Social and Environmental), proposed by the method, are analyzed individually and, later, added together to generate a sustainability index. From the generated index, sustainability is analyzed by observing the parts complexity of the system and the whole.

The APOIA Novo-Rural method uses the systemic approach in the sustainability assessment process and proposes the environmental impact integration to social and economic aspects in the evaluated dimensions. APOIA adopts five dimensions: landscape ecology; environmental behavior quality (atmosphere, water and soil); sociocultural values; economic values; and management/administration. Each dimension generates an index that, when grouped together, forms the general environmental impact index. This method considers the interaction between the indicators, with a focus on identifying and quantifying trade-offs between the different dimensions. The trade-off refers to the greater relevance that one method can attribute to one investigated system element than to another, through the multiple functions performed by agriculture. Thus, one of the difficulties of assessing sustainability with the systemic approach is in the operationalization of the system concept during the results interpretation.

The system conceptual notion adds a dynamic of complexity to the sustainability idea of agricultural systems, which challenges researchers and technicians to interdisciplinary work, breaking barriers between the different sectors that make up agriculture and livestock (Marzall and Almeida, 2000). The basic assumption of the systemic approach is environmental complexity (Sanchez and Matos, 2012). The complexity concept explains the system non-linearity, its dynamics and ability to recover after a disturbance. In agroecosystems, the various behaviors (balance and imbalance) that the system may present, over time, show its complexity, in relation to its initial conditions (balance) and disturbances (imbalance) (Silva Neto, 2009).

The systemic approach importance situated in the integrated understanding of the functional skills that represent each part of the system. In the IDEA method, despite being a normative method, its indicators have systemic characteristics that lead to integrated understanding of environmental, social and economic aspects of agriculture. Some indicators used in one scale can be repeated in another, presenting concern in showing that the same element can be influenced or may influence differently another system aspect. Analyzing the IDEA method, Cândido et al. (2015) pointed out that this method fails to present a systemic approach, as it does not promote the interaction between these parts, focusing on the dimension with the lowest score, despite having indicators that represent the different parts of the system. However, this condition can be circumvented from the interpretation given by the method researcher or executor, so that

one observes the influences that an element can produce in another element and, consequently, in the entire studied system.

In APOIA Novo-Rural, the elements systemic integration occurs from the indicators selection to the final aggregation of the environmental impact index. This effect of adding different natures elements in the same dimension is considered, by the authors of the method, as the great advantage in relation to other available methods (Rodrigues and Campanhola, 2003), because it breaks with the disciplinary analysis intertwining the anthropic interventions in the changes environmental issues.

3.2.4 Stakeholder participation

Stakeholders are the groups interested in the sustainability assessment process. In agriculture, farmers themselves, agricultural technicians, research institutions and/or governmental and non-governmental bodies (Cândido et al., 2015) form these groups. Stakeholder involvement can occur in all evaluation process stages, from creation (concepts definition, objectives, indicators selection and goals definition), application and monitoring or in just a few stages of this process. Regarding the stakeholders participation in the evaluation process, the methods can be classified in a top-down (from top to bottom) and bottom-up (from bottom to up) approach.

In the three analyzed methods, stakeholder involvement is limited to the stages of indicators application and monitoring. Farmer is responsible for providing the data and he can not classify it personally. In IDEA, a top-down perspective lead to definition of the objectives and evaluation criteria, that is, the evaluation criteria are critically reviewed by researchers and complemented according to theoretical concepts related to sustainable development (Binder et al., 2010). In APOIA and ISA, stakeholder involvement occurs both in the top-down type, derived from researchers, and in a transdisciplinary bottom-up process that concentrates the participation of various scientific areas interested in the evaluation, combining qualitative (interviews and sensory evaluation) and quantitative (linear programming) tools (Binder et al., 2010; Sanchez and Matos, 2012).

For the data provision in IDEA, as it is a self-assessment tool, the farmer's opinion is also included, through notes, as to the aspects that involve life and territory quality. Although the top-down process favors the comparison between the different systems, target audience low participation in the evaluation procedures definition is one of this approach disadvantages, making it difficult to execute the recommendations that make the systems more sustainable (Cândido et al., 2015).

3.2.5 Suitability in different realities

Agricultural systems are heterogeneous, formed by subsets that group different systems, abiotic factors (relief, geology, climate, hydrology) and biotic factors (living communities, plants and animals) as well as different use and socioeconomic exploitation forms (Bertrand, 2009). The adequacy levels of the sustainability assessment method are characteristics that allow its reapplication in different contexts. In this sense, the three sustainability assessment methods have rigid matrices, with pre-defined indicators and assessment system.

The IDEA indicators and calculations matrix presents a standardization adjusted to the French and European agricultural systems context, which makes it difficult to apply in other contexts without

adaptations. The IDEA method is flexible for adaptations, despite having a rigid matrix, with its application reports in countries such as Tunisia, Mexico and Brazil (M'hamdi et al., 2017; Sala et al., 2015; Jesus, 2003). For its reproduction within the Brazilian context, adaptations in some indicators calculation systems were necessary, as well as indicators exclusion due to measurement or estimation difficulties or not being suitable for Brazil (Jesus, 2003).

On the other hand, the APOIA Novo-Rural and ISA matrices were developed and validated in Brazilian agroecosystems. Despite this, there are reports on the need to adapt the method to different contexts in Brazil, due to the great environmental, social and economic diversity. Pereira (2008) and Morais (2010) reported the needs for adaptations of APOIA Novo-Rural. These authors mainly highlighted the need for adjustments in the social indicators parameters in order to include different systems, especially family members. Since 2009, the ISA has been applied by EMATER technicians in several municipalities in the Minas Gerais State and it has shown sensitivity to Brazilian inter and intraregional variations (Ferreira et al., 2012).

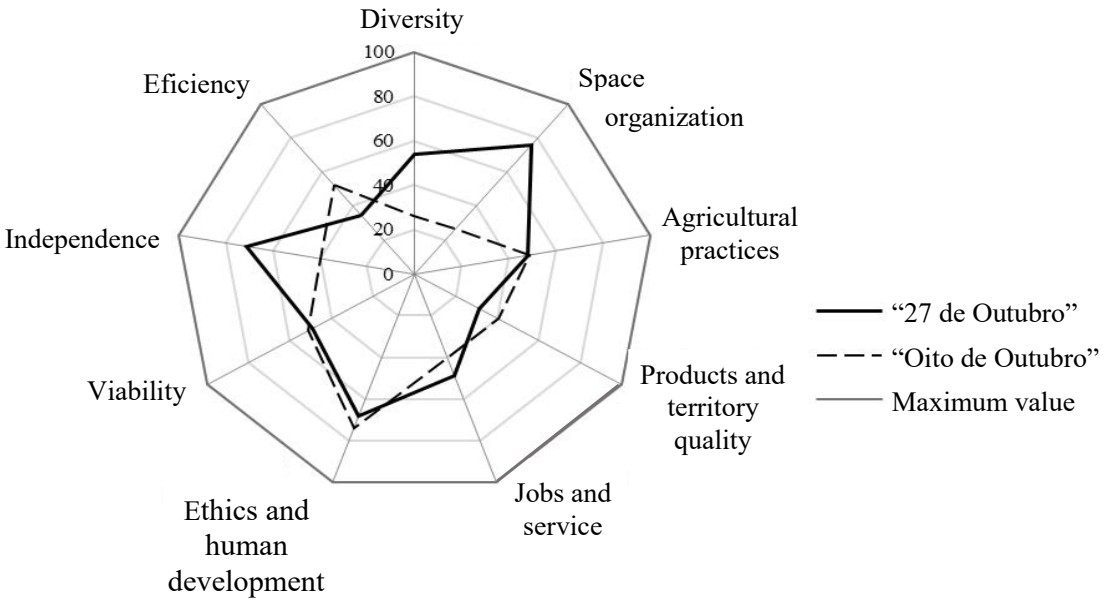
3.3 Application of IDEA, APOIA Novo-Rural and ISA methods on corn exploration in the Sergipe State

Para a realidade destes Assentamentos, o método IDEA necessitou de adaptações nos indicadores A9, A12, A14, A15, A18, B15, C1 e C4 e exclusão dos indicadores B12 (Contribuição ao equilíbrio alimentar mundial) por não ser aplicável ao Brasil e C5 (Transmissibilidade) pela ausência de dados e, por ser, parcialmente, contemplado no indicador B11 (Perenidade prevista).

For these Settlements reality, the IDEA method required adaptations in indicators: Legal contribution to environmental issues in the territory, Fertilizing, Pesticide, Veterinary treatment, Energy dependence, Work intensity, Monthly economic viability (R$) and Contribution of external rents; and exclusion of indicators: Contribution to world food balance, as it is not applicable to Brazil, and exclusion of Transmissibility, due to the lack of data and, partially, being included in indicator Expected duration.

The “Oito de Outubro” settlement has its sustainability limited by the Agroecological Scale (Diversity, Space organization, Agricultural practices) that obtained the lowest score (34/100), while the “27 de Outubro” settlement has its sustainability limited by the territory social scale (products and territory quality, jobs and services, ethics and human development) in 49.3 out of 100 points (Figure 1). The “Oito de Outubro” settlement properties have their activities related to the corn and livestock cultivation, which limits the diversification and ecological balance of the cultivated area. The “27 de Outubro” settlement properties are mainly affected by the landscape low quality around the residences, the lack of access to basic sanitation and garbage collection services and low capital potential invested in production.

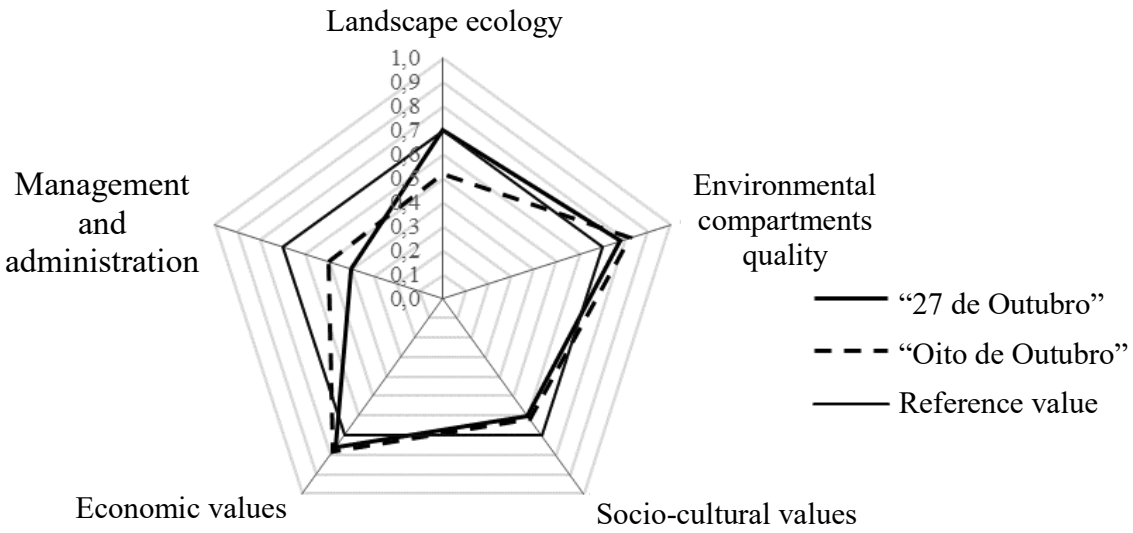
Figura 1. Sustainability assessment by different indicators in the IDEA method for “Oito de Outubro” and “27 de Outubro” rural settlements, in the Simão Dias county, Sergipe, Brazil.



Source: Santana (2019)

The APOIA Novo-Rural application in the "Oito de Outubro" and "27 de Outubro" rural settlements properties showed the Environmental Impact Index of the activity of 0.6 (below the reference value 0.7) being considered an unsatisfactory sustainability level (Figure 2), especially in the dimensions that contemplate the sociocultural values and, management and administration (Araújo, 2018). These limitations are related, respectively, to the producer's qualification and the lack of financial control that provides better properties performance. APOIA Novo-Rural showed the need to improve technical monitoring in the cultivation stages for all properties, given the economic importance of corn for the studied properties.

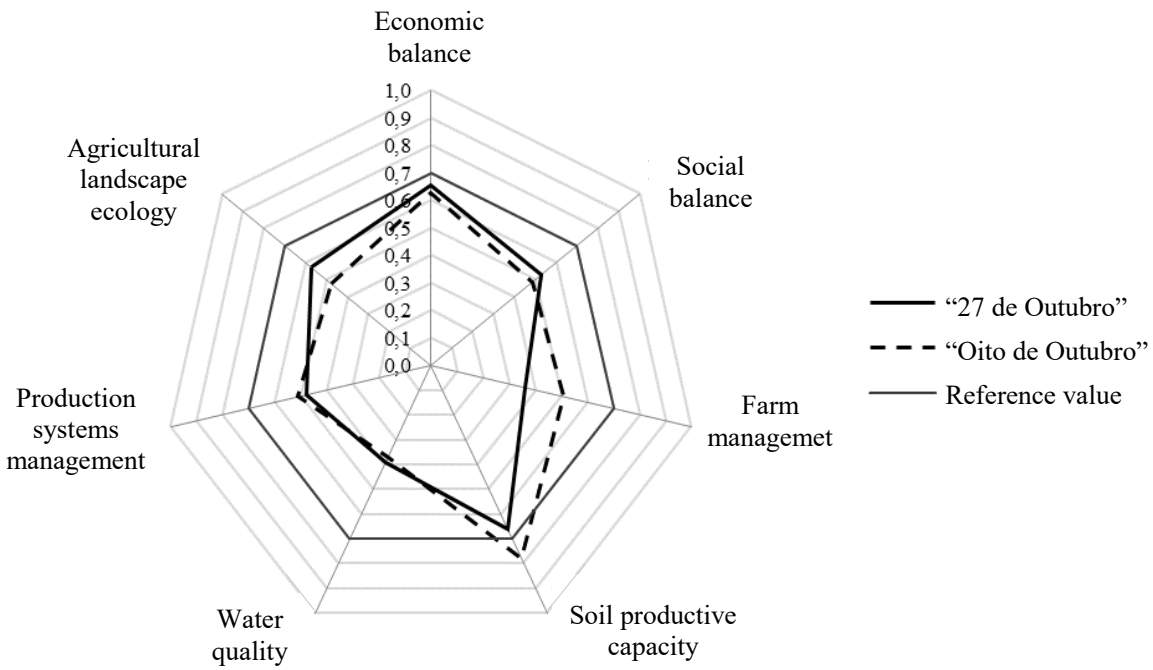
Figura 2. Sustainability assessment by different indicators in the APOIA Novo-Rural method for "Oito de Outubro" and "27 de Outubro" rural settlements, in the Simão Dias county, Sergipe, Brazil.



Source: Santana (2019)

The general sustainability index obtained by the two settlements was 0.5 (below the reference value of 0.7), which showed a fragility in the level of sustainability (Figure 3), mainly related to the sub-index water quality and management rural establishment, emphasizing the lack of technical assistance to farmers.

Figura 3. Sustainability assessment by different indicators in the ISA method for "Oito de Outubro" and "27 de Outubro" rural settlements, in the Simão Dias county, Sergipe, Brazil.



Source: Santana (2019)

4. Conclusions

The comparative analysis of the sustainability assessment methods (IDEA, APOIA Novo-Rural and ISA) shows that each of them presents a multidimensional structure of agricultural sustainability. The set of indicators for each method, although they are quantitatively different, contemplate the elements diversity that involve agricultural systems.

The different elements (management and technical performance, management and socioeconomic performance, soil, water, air, landscape structure and cultural resources – Table 01) within the different dimensions of each method evaluation provided good conditions for the analysis and research of the agroecosystems involved in this comparative study. The performance characterization of agricultural properties and their representations are the main strengths, because it takes the farmer to a critical view of his own property, made possible by the holistic view.

The three evaluated methods proved to be particularly interesting as tools of reflective practice for inserting sustainability in agricultural systems, especially at a local scale. IDEA, as a pedagogical tool, directs the assessment towards the greatest possible awareness of the environmental processes surrounding rural property. In APOIA Novo Rural and ISA, reflective practice is encouraged by final report preparation

that shows, to the farmer/manager, his activity impacts on the environment, being susceptible to extension actions for improvements. A common characteristic among the three analyzed methods are the provided scenarios, which are subject to comparisons and future analyzes, providing support to decision making.

The main difference exposed by the methods is in the indicators integrative assessment, as well as the trade-offs. ISA and APOIA Novo-Rural make an explicit integrative assessment between social, economic and environmental indicators and with trade-offs between them for the elaboration of an environmental impact index. In contrast, IDEA does not have an integrative relationship and there is no trade-off between the agro-environmental, socio-territorial and economic dimensions.

The advantage of IDEA, in relation to ISA and APOIA Novo-Rural, is its didactic structure, wich favors the evaluation in a greater number of locality or region rural properties, being able to be evaluated together and compared among themselves, with faster and cheaper evaluation. The disadvantage of IDEA, in relation to the other two other methods, is the data organization and structuring need to start the evaluation process, as well as the difficulty of obtaining some data, which limits some indicators operationalization, mainly due to the need for adequacy on international scale.

APOIA Novo-rural and ISA, despite having indicators validated worldwide, also present adaptation needs for other countries, since the parameters adopted are specific to Brazilian context.

The analyzed methods can complement each other in assessing sustainability processes of agroecosystems, since each of them explores its indicators distinctly, even though there are similarities between most of them.

The methods can potentially contribute to agricultural holdings improvement, by ordering and identifying both limiting and potential aspects of these holdings and their determining factors, bringing them closer to an environmentally balanced, economically viable and culturally accepted agricultural holding.

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Teachers' Physical Activity: A Necessity for Stability of Schools' Culture During the COVID-19 Pandemic

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Abstract

The recent COVID-19 outbreak has caused confusion and uncertainty to many educational organizations worldwide, forcing school leaders to weave through many school priorities. As schools take on online teaching, teachers were compelled to sit on their chairs, interacting with students using the screens for more than four hours every day. This has resulted in a decrease in physical activity, affecting their health and quality of teaching. Unfortunately, the dichotomy is as teachers care for their students' physical and mental health, teachers' physical well-being is not a priority in most schools' culture during this pandemic.

This paper aims to address this gap in teacher's lack of Physical Activity, which is necessary to help stabilize the school culture during this pandemic. It will highlight school leaders' critical role in promoting physical well-being as part of the school culture. Moreover, it will discuss the benefits of teachers staying active, and it will also present possible ways to foster a culture geared toward teachers' involvement in physical activities.

Keywords: School Culture, Online Education, Physical Activity, Mental Health, COVID-19 Pandemic

1. Introduction

The world was enveloped in chaos and uncertainty when the coronavirus pandemic started last December 8, 2019, that began in Hubei province, China (WHO, 2020b). It caused significant public health emergencies (Park, 2020) and forced governments to impose shutdowns that seriously affected the economy and severely disrupted education (Jan, 2020). The COVID-19 is highly contagious, and as of February 16, 2021, it has spread globally to 219 countries infecting 108.2 million and killing about 2.3 million people (WHO, 2021).

Since the global health outbreak started, education leaders have continuously struggled with critical issues on health and safety measures, economic and labor concerns, technostructure, and pedagogies upgrades (Messano et al., 2020). At the same time, school leaders aimed to balance the school culture, promoting positivity and students and staff's well-being (Confeld, 2016).

With the worsening of the COVID-19 pandemic, schools have shifted their education platform to online distance learning to curb the virus's spread and observe safety health protocols. China is the first one to use online education (Cai & Wang, 2020). The Chinese government launched the "Schools Out, But Class On," a large-scale campaign to use online education to mitigate and reduce the pandemic's effect on students' learning loss, mental health, and physical well-being. The initiative had a profound impact not only in China but served as an inspiration for other countries to follow (Zhou et al., 2020).

With the given situation, school leaders and teachers continued supporting students and parents with their mental and physical needs; however, less focus was given to teachers on their physical wellness. They continue to wrestle with all the demands of online teaching (McClintok, 2021).

This concept paper aims to address the gap in teacher's lack of Physical Activity, which is necessary to help stabilize the school culture during this pandemic. Despite the scarcity of information about this topic, this paper will highlight school leaders' critical role in promoting physical well-being as part of the school culture. Moreover, it will discuss the benefits of teachers staying active, which can help with mental health concerns, prevent the possible development of acute and chronic diseases, and boost the immune system. Furthermore, it will also present possible ways to foster a culture geared toward teachers' involvement in physical activities.

2. Literature Reviews

2.1 School Culture

The education communities around the world are currently in the midst of something extraordinary and unconventional. They have dealt with challenging choices on whether to open the school this year, what educational platform to adopt, what training is needed by teachers, what resources to procure, how to go about teaching considering the health and safety protocols, and what instructional and assessment strategies to give students to optimize the quality of learning (Malkus et al., 2020).

Trinidad (2021) study agreed that schools' focus is often on technostructure, students, and pedagogies. Moreover, the author argued that other fundamental issues like teachers' mental and physical health are set aside due to competing values in the school culture as decided and prioritized by the school leaders to address the current crisis.

School culture is defined as a set of human activities that deals with thinking, doing, and making. (Tharp, 2009 as cited by Confeld, 2016). Moreover, it involves adaptation, integration, sharing, and

learning. These processes are vital for organization leaders to understand to shift, upgrade or provide the appropriate changes in the schools' vision, mission, and norms to meet challenges or capture the best experiences in any crises (Confeld, 2016). School organization leaders need to develop a stable and robust school culture that will generate positivity to balance emotions and be attuned to teachers' needs (Barry et al., 2017; Buskila & Chen-Levi, 2021).

Gruenert and Whitaker (2015) stated that leaders should recognize what it has, what it needs, and then start shaping the school culture. It is also critical to involve the team, describe the required changes, and provide the capability to change. Additionally, an effective school leader's strength is understanding his employees' needs (Rath & Conchie, 2008 as cited by Confeld, 2016).

As school organizations adapt and change during this pandemic, school leaders, teachers, and other staff should all promote and contribute to the stabilization of school culture that is not limited to a top-down directive but approved by consensus. Furthermore, given the virus's potential effect on one's well-being, health has become of paramount importance in mitigating the spread of COVID-19 (Trinidad, 2021).

2.2 Online Teaching Harmful Effects

The COVID-19 outbreak has complicated teachers' facilitation of learning as the government declared school closures and students stayed at home. These restrictions hampered physical activities to manage the virus's spread (Rutkowska et al., 2021). On the contrary, educators hurriedly reinvented learning delivery and shifted to online teaching (Heffernan & Wilkinson, 2020). Teachers who are used to work on their feet are now facing the computers all day (Fleming, 2020), ushering in a sedentary lifestyle (McClintok, 2021). This new technology-driven instruction has brought unwarranted stressors and greater demands on their physical health (Trinidad, 2021).

Although teachers remarkably found engaging ways to teach online as they cope with the unprecedented stress (Klapproth et al., 2020), this resulted in a continuous high-stress level which is harmful to health (Messano et al., 2020) and diminishes productivity and performance efficiency (Niessen et al., 2017).

In the study conducted by Klapproth et al. (2020), the authors enumerated the stressors that affected 380 teachers who taught online, which resulted in teachers experiencing medium to high-stress levels during this pandemic. The stressors that heightened the teachers' stress levels were low ICT competence, lack of adequate devices and resources, internet connectivity problems, increased workload, and lack of school support, exacerbated by personal matters. The study also validated that those who taught online for more than 4 hours significantly experienced higher stress levels.

Without a doubt, staying home and excessively sitting all day are enormous challenges for teachers who are used to working in school and moving around. Although it is safe to work from home or work socially distant apart from colleagues in the school, regrettably, it has drastically reduced the amount of

physical activity (Chen et al., 2020). Some teachers are now experiencing health problems associated with sedentary behaviors in conducting online teachings such as tennis elbow condition, eye strains, body ailments, and other health diseases (Fleming, 2020). The decrease in physical activity can increase the risk of chronic health issues (Chen et al., 2020), such as obesity, hypertension, and heart diseases (Wu et al., 2017).

Furthermore, a study showed that limiting physical activity for 14 days negatively impacted health, affecting the quality of life. The results of decreasing the amount of physical activity are increased body fat, reduced heart capacity and lung capacity, atrophy in the lower limb muscles and loss of lean muscle mass, adverse changes in the metabolism of insulin and glucose, and other chronic diseases (Bowden Davies et al., 2019, as cited by Rutkowska et al., 2021).

2.3 Required Physical Activity

Dr. Powell once said, "some activity is better than none, and more is better than less" (Powell et al., 2011). Due to the lockdown, quarantine and isolation became the norm for all households and establishments that resulted in having most of the population not performing the minimum physical activities needed for better health (Katzmarzyk et al., 2019).

Based on the World Health Organization (WHO, 2020a) guidelines, adults should perform at least 150 to 300 minutes of moderate exercises or do 75 to 150minutes of vigorous training within a week. They also advised doing strength training, aerobic physical activities, or combining these to reap the health benefits. WHO argued doing away with a sedentary lifestyle and replacing this with increased physical activity.

Mohamed & Alawna (2020) affirmed that since the coronavirus targets the immune and respiratory systems, performing regular moderate aerobic exercises will improve and strengthen these functions and help ward off chances of being infected.

2.4 Benefits of Physical Activity

Many studies correlate the profound benefits of doing regular physical activities with better health. It benefits the body and the mind, for it addresses mental health conditions by lowering depression, anxiety, cognitive decline, and dementia (WHO, 2020c). There is also a correlation between the frequency of exercise and personal health disposition. A study shows that increased physical activity frequency resulted in a better mood, espousing positive mental health (Brand et al., 2020).

Additionally, Fröberg, A. (2020) study confirmed that Physical Activity reduces depression, anxiety and improves an individual's overall general health condition. The authors concluded that being active could lower the risk of lingering diseases such as heart conditions, type 2 diabetes, and other health ailments. Conversely, a decrease in physical activity could eventually lead to acute and chronic health diseases (Hall et al., 2020).

Therefore, a sedentary lifestyle should not be encouraged; instead, any movement is better than doing nothing (Chen et al., 2020). A study revealed that increasing aerobic exercises also increase the body's defense against diseases and improves the immune system. Doing moderate physical activities in less than 60minutes, such as walking, jogging, or running, can benefit the immune system, especially against respiratory infection (Fröberg, 2020). This means that the effects of exercises and being physically active can help counter the risk of contracting COVID-19 (Mohamed & Alawna, 2020).

2.5 Sample Physical Activity During the Pandemic

Chen et al. (2021) highlighted that exercises at home should be simple, safe, and easy to perform. They also emphasized to engaged in a combination of strength training, cardio, stretching, and balance exercises like Yoga and Pilates to maintain physical well-being. Furthermore, they proposed walking around the house or in the work area, climbing stairs, utilizing home or office materials and furniture to assist in doing lunges, squats, pushups, and weightlifting for a minimum of 30 minutes every day.

Besides, any home exercise or activities can be done, such as gardening, cleaning, or doing household chores, as long as movements are incorporated daily (Fröberg, 2020).

During this pandemic, there is a proliferation of internet sites, exercise videos, or workout mobile applications to help facilitate and motivate engaging in physical functioning (Chen et al., 2021). At present, there are a hundred of thousands of applications available across the world to assist in health and fitness matters. Anyone can install these applications or electronic platforms on different devices such as mobile phones, watches, and laptops. They serve as a fitness pal to record health data, provide exercise programs, track total steps, monitor heart rates, detect sleep patterns, log food consumption, calculate calories and even suggest nutritious food (Gordon et al., 2020).

3. Conclusion: Implications and Future Direction

In sum, the pandemic has created extraordinary challenges to the school organizations, particularly to school leaders and teachers who are serving as front liners to help contain the spread of COVID-19 while addressing online teaching demands. Unfortunately, in meeting these challenges, teachers' well-being is placed in a precarious predicament as school leaders focused on their chosen top priorities. School organizations must understand that health should never be regarded as a second priority and prolonged inactivity poses dire consequences on teachers' mental and physical well-being, which affects their teaching performance. The dichotomy of being concerned with students' and parents' physical and psychological well-being while leaving behind teachers' health welfare needs to be addressed as resolved as revealed by the negative effects of a sedentary lifestyle or doing very little physical activity.

Therefore, school leaders must cultivate a culture that underpins the inclusion of regular physical activities in the teachers' daily routine, promoting positive mental health and boosting the immune system, thereby lessening the chances of having acute or chronic diseases. Overall, the benefits of exercising and

being active are a great deterrent against the highly contagious COVID-19.

3.1 Implications

This concept paper has several implications. First, it highlighted the vital role of school leaders in incorporating a wellness program geared towards teachers' Physical Activity. Second, it stressed the importance of movements and exercises, thereby including Physical Activity programs within the school hours would encourage teachers to value the culture of being physically active. Third, school organizations need to find ways to implement and monitor teachers' regular physical activities. It would be helpful if school organizations create fitness schedules incorporating it within the allotted working time and make it a routine. And fourth, school leaders can also create reward systems to motivate teachers to participate and pursue healthy choices. All these can be scheduled and implemented online.

3.2 Future Direction

The research suggests that:

1. Schools create an online Physical Activity program for their staff with an Assessment tool to monitor compliance.
2. Researchers undertake studies on the culture of schools offering online Physical Activity Programs for their staff.

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OZONIZED AND NATURAL COMPOUNDS FOR *IN VITRO* *ACINETOBACTER BAUMANNII* TREATMENT

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Abstract

Acinetobacter baumannii stands out as an opportunistic pathogen responsible for Healthcare-Associated Infections. This study aimed to evaluate the efficacy of natural oils in natura and ozonated on A. baumannii mortality. The randomized experiment used the A. baumannii strain and natural oils (palm, canola, and coconut) ozonized and in natura (control group). Minimum inhibitory and bactericidal concentrations and chromatography were employed in the study. Through the ozonized and fresh oils antimicrobial action, the natural oils' effectiveness and the bacteria mortality were evaluated. The data was submitted to the Mann-Whitney and Kruskal-Wallis tests. When comparing the natural oils, ozonized canola oil stood out as the most efficient in destroying the bacteria. The other ozonized oils showed a 90% reduction in the microbial load in the first ten minutes of treatment. For use in natura, palm oil stood out with 85.9% microbial load reduction. According to the results obtained, the antibacterial activity of natural oils is remarkable, showing that they were expressively effective in inhibiting the A. baumannii growth, presenting themselves as a new adjuvant therapy antibacterial drug. The study concluded that the ozonized oils are more efficient in both MIC and MBC when compared between the ozonized and the untreated groups. The bacteria are sensitive to the ozonized oils.

Keywords: *Acinetobacter baumannii*; Vegetable oils; Ozone; Antimicrobial activity; *In vitro* technique.

1. Introduction

Acinetobacter baumannii is a Gram-negative aerobic bacterium that stands out as an important opportunistic pathogen and responsible for Healthcare-Associated Infections (HAIs). Its clinical importance has been associated with high prevalence in epidemics and endemic situations, antibiotic resistance, biofilm-forming in medical devices, and desiccation resistance[1-3].

Thus, this bacterium has shown resistance to antibiotics frequently used in clinical practice[4]. Therefore, it is used as a treatment of the most potent antibiotics, such as carbapenems. However, by using these antibiotics, there is an increase in strains resistant to these drugs, justified by the emergence of β-lactamases[2].

Due to this fact, the use of lipopolypeptides (polymyxin B and polymyxin E) has been referred to as a "last resort." It is increasingly required for *A. baumannii* eradication therapy[5].

Lipopolypeptides during the 1960s were widely used in treatment against *A. baumannii* and *Pseudomonas aeruginosa* infections, being replaced by effective and less toxic drugs, such as cephalosporins and aminoglycosides[5,6]. In the 1990s, with the development of multidrug-resistant strains of *A. baumannii* and *P. aeruginosa*, its use was reinstated, especially in the case of carbapenem-resistant samples. It is important to emphasize that polymyxins' continuous use causes the development of resistant samples of *A. baumannii*, which stands out the resistance rates of 40.7% in Spain and 30.6% in Korea[7,8]. For many countries, polymyxins have been reported as the only option for treating severe infections caused by *A. baumannii*[9].

Besides resistance, antibiotics used against pathogenic microorganisms can induce severe side effects, especially in patients under prolonged treatment. They can also alter the microbiota, which is important for intestinal eubiosis and the whole organism. Antimicrobial agents that increase dysbiosis create an ideal environment for pathogenic microorganism colonization and other infections with potential recurrent episodes[10,11].

As a result of *A. baumannii*'s multidrug resistance to antibacterial drug treatment, and especially the mortality associated with infection by the bacteria concomitant to inadequate therapy, the search for new antimicrobial agents began, among natural products, which contain hundreds of naturally active ingredients in various proportions, eliminates the resistance risk, because microorganisms are not able to adapt to their heterogeneous structures[12].

Ozone is widely recognized as one of the best bactericidal, antiviral, and antifungal agents. It has currently been used as a therapeutic mediator in chronic wounds, ulcers, and ischemic wounds, due to its ability to diminish bacterial infections and heal dermal damage caused by the "oxidative death" effect on microorganisms[13,14].

Ozonated oils have exhibited antimicrobial activity against bacteria and fungi. They can be suggested for use in chronic local infection prevention and treatment, in suitable formulas, and controlled conditions, as an alternative to topical antimicrobials[15,16]. This may be useful to contrast the widespread and indiscriminate use of antibiotics, which has led to bacterial resistance[17].

In this context, the present study aimed to evaluate the antimicrobial activity and ozonated vegetable oils for the in vitro treatment of *Acinetobacter baumannii*.

2. Materials and Methods

2.1. Study design

The *Acinetobacter baumannii* strain was analyzed in the microbiology laboratory in a randomized experimental design study. The treatments for *A. baumannii* consisted of two groups of natural oils, one

group of ozonated and non-ozone oil ("*in natura*" means control group), conducted in the laboratory of Universidade Brasil, Fernandópolis, SP, from August 2019 to February 2021.

2.2. Biological sample and natural compounds

Acinetobacter baumannii ATCC (*American Type Culture Collection*) 17978 strain was used, cultivated in blood agar medium (OXOID®) for 24 hours, and incubated at 37ºC. Three types of natural compounds were used: canola oil (Liza®), coconut oil (Katigua®), and palm oil (Hemmer®).

2.3. Ozonation of the natural compounds

For ozonation, 1 liter of each natural oil was used. Ozone was produced by a generator (Ozon & Life) and an oxygen cylinder. The canola and palm oil were exposed to ozone directly through a diffuser for 4 hours at 25°C, while the coconut oil was ozonized for 6 hours at the same temperature. Ozonation was conducted in a fume hood in a chemistry laboratory according to international safety standards. After ozonation, 0.1 mL of each oil was inoculated in Petri dishes containing *Trypticase Soy Agar* (TSA) (OXOID®), incubated at 37°C for 24 to 48h to verify microbial growth absence. The oil that did not present any microbial colony was considered sterile. The ozonized oils were kept under refrigeration (8ºC).

2.4. Gas chromatography for chemical characterization of ozonized and *in natura* oils

Gas chromatography was used to separate and analyze the chemical mixtures of ozonized and *in natura* canola, coconut, and palm oil. In this process, a gas reservoir with flow rate/pressure control (cylinder containing carrier gas under pressure), a sample injector or vaporizer (block connected to the chromatographic column and the carrier gas feed cylinder to introduce the sample into the column), a chromatographic column and column oven were used. The oils' density was verified by the method of *The United States Pharmacopeial Convention*[18] and to determine the oils' peroxide index, the Cd 8-53 method of the *American Oil Chemists Society*[19] was utilized. According to the *Association of Official Analytical Chemists*, total fatty acid content, acidity, iodine index, and saponification index were determined[20].

2.5. Bacterial inoculum patterning

The bacterial strain was inoculated in *Brain Heart Infusion* (BHI) broth (OXOID®) and incubated for 24 hours in aerobic conditions at 37ºC. Afterward, it was centrifuged (4000 rpm) for five minutes. Then, the supernatant was discarded, and the sediment was resuspended in dimethyl sulfoxide (DMSO) (Synth®) and again submitted to centrifugation. This procedure was repeated five times to remove existing components in the culture medium[21] that could interfere with the minimum inhibitory concentration assessment. Then, the bacterial solution was diluted in DMSO using MacFarland's 0.5 scales, equivalent to a concentration of $1.5x10^8$ colony forming units (CFU)/mL^{-1}.

2.6. Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) measurement

The bacterial sensitivity test was performed in a 96-well microtiter plate to determine the MIC, following the *National Committee for Clinical Laboratory Standard*[22]. Initially, 50 µL of BHI broth was

dispensed into the wells. In the first row, 50 µL of the oils were added (obtaining the first dilution [50%]). Next, serial dilutions were performed in the columns in the six subsequent wells, removing 50 µL from the well with the highest concentration to the next well, until a concentration of 0.781% was obtained (dilutions 50%, 25%, 12.5%, 6.25%, 3.125%, 1.562%, and 0.781%). A 50 µL aliquot of the bacterial inoculum was then added to each well and incubated for 24 hours at 37°C under aerobic conditions. To determine the MIC, 50 µL of the dye 2,3,5-*Triphenyltetrazolium Chloride* (TTC), which reflects the activity of the dehydrogenase enzymes involved in the respiration process, was added to each well. The MIC was defined as the lowest concentration of the oil capable of inhibiting bacterial growth.

The MBC was measured based on Favre's methodology[23]. It was taken 100 µL of each sample after MIC results, inoculated in blood agar medium, incubated for 24 hours at 37ºC in aerobiosis. Bacterial growth was evaluated, and MBC was considered to be that which showed negative culture or mean of 0.1 CFU. The experiments of MIC and MBC were performed in triplicate.

2.7. Bactericide Kinetics of ozonated and *in natura* oils

The methodology described by Allahghadri[24] was employed. 40 µL of each oil and 5 mL of BHI broth containing a bacterial suspension of 10^6 CFU mL-^{1} were added in tubes. Samples of 0.1 mL were taken every 10 min for 480 min. Samples were immediately washed with sterile phosphate buffer, pH 7.0, centrifuged (10,000 rpm), resuspended in buffer, then inoculated onto BHI Agar, incubated for 24 hours at 37°C. The mechanical colony counter counted CFU. After the colony counting, the microbial load variation was assessed to observe which oil showed the highest negative variation (reduction) in the microbial count. The experiment was carried out in triplicate.

2.8. Data analysis

The data were submitted to a descriptive analysis of the minimum inhibitory and bactericidal concentrations of each of the natural oils according to the treatments (ozonized and *in natura*). The Mann-Whitney test was applied to compare the microbial count and the microbial count variation for the oils evaluated according to the type of treatment (ozonized vs. *in natura*) Kruskal-Wallis test was applied to compare the microbial count and the microbial count variation according to the type of oil. Line graphs were applied to analyze the microbial count according to treatment (ozonated and *in natura*). Statistical tests were applied with a significance level of 5% ($P<0.05$).

3. Results

Acinetobacter baumannii proved to be sensitive to the natural oils used in the study. It was possible to determine the minimum inhibitory concentrations and minimum bactericidal concentrations and verify the oils' physicochemical chromatographic differences (ozonized and *in natura*) when submitted to treatment.

Table 1 shows the MIC and MBC for the ozonated and the *in natura* oils. In this Table, the inhibitory and bactericidal concentrations of the *in natura* oils are higher than the ozonized oils. This result indicates that ozone treatment increases the natural oils' antimicrobial effect since a lower concentration of the oil is

required for the antimicrobial effect to be effectively observed. Among the natural oils evaluated, palm oil is the most noteworthy, showing the lowest minimum inhibitory concentration than the other natural oils.

Table 1. Minimum inhibitory and bactericidal concentrations for each of the oils evaluated in the study.

Natural Oil	Treatment	MIC[1]	MBC[1]
Canola	*in natura*	50%	50%
	Ozonized	25%	25%
Coconut	*in natura*	25%	50%
	Ozonized	12,5%	25%
Palm	*in natura*	25%	50%
	Ozonized	6,25%	12,5%

MIC[1]: minimum inhibitory concentration and MBC[1]: minimum bactericidal concentration.

Table 2 shows the *A. baumannii* microbial counts subjected to the natural and ozonated oils at their respective MBCs. This Table shows that the natural oils did not significantly differ from the *A. baumannii* control (P>0.05). The comparison between the different oils *in natura* also showed no significant differences in microbial counts (P=0.351). A similar result was found when comparing ozonated oils for microbial counts (P=0.298).

Table 2. Mean ± standard deviation (Median) of *Acinetobacter baumannii* submitted to the *in natura* and ozonated oils.

Oils (MBC *in natura*/MBC ozonized)	*in natura*	ozonized	P[1] Value
Canola (50%/25%)	$1,3.10^5 \pm 3,6.10^5$ ($9,4.10^2$)	$1,7.10^3 \pm 2,9.10^3$ ($2,6.10^2$)	0,458
Coconut (50%/25%)	$1,1.10^5 \pm 2,8.10^5$ ($5,7.10^2$)	$2,1.10^5 \pm 5,3.10^5$ ($5,3.10^2$)	0,963
Palm (50%/12,5%)	$1,5.10^5 \pm 3,9.10^5$ ($2,2.10^2$)	$2,0.10^5 \pm 4,6.10^5$ ($2,8.10^3$)	0,115
P[2] Value	0,351	0,298	

P[1] Value referring to the Mann-Whitney test at P<0.05. P[2] Value referring to the Kruskal-Wallis test at P<0.05.

Figure 1 shows the confidence interval for each of the oils according to the treatments, and Figure 2, the confidence interval according to the types of natural oils. The black circles and squares in the Figures indicate the means and medians of the microbial counts.

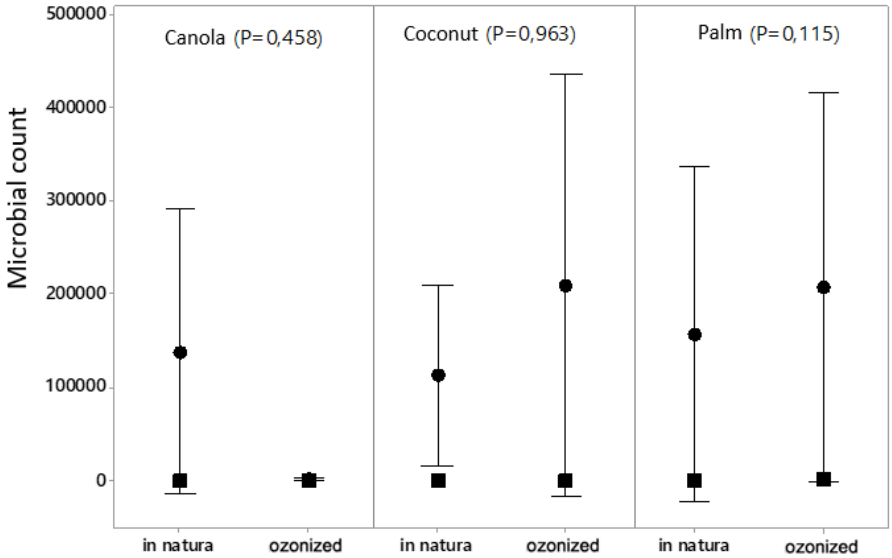

Figure 1. Confidence intervals (95%) of microbial counts according to treatments

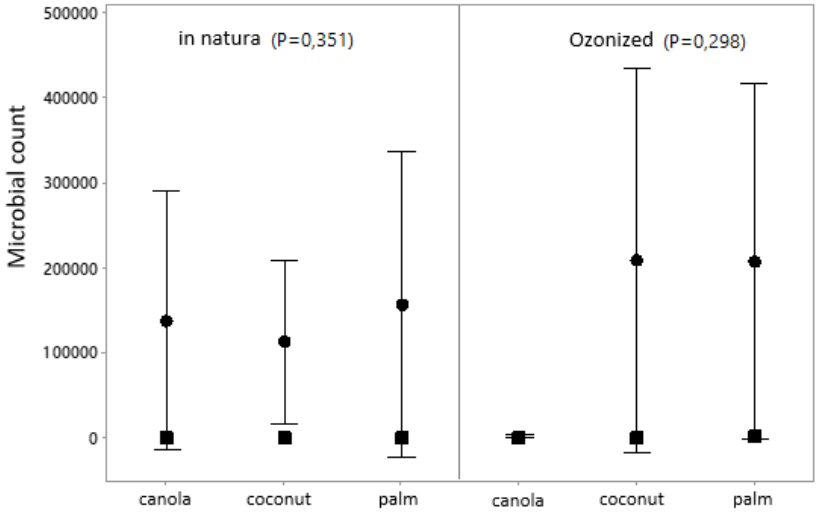

Figure 2. Confidence intervals (95%) of the microbial counts according to the natural oils type.

Figures 1 and 2 show no statistically significant difference in microbial counts according to the treatment and according to the type of natural oil, but it is clear that the ozonized canola oil showed zero microbial counts compared to the other oils studied.

Figures 3, 4, and 5 show each of the natural oils' microbial count behavior according to the treatments' evaluated exposure times.

Figure 3 shows the efficiency of the time of *A. baumannii* inhibition, where its efficiency at zero minutes can be observed for ozonized canola oil compared to the *in natura* oil, whose microbial count at this time was 10^6 bacteria. After 30 minutes, both treatments completely suppressed *A. baumannii*.

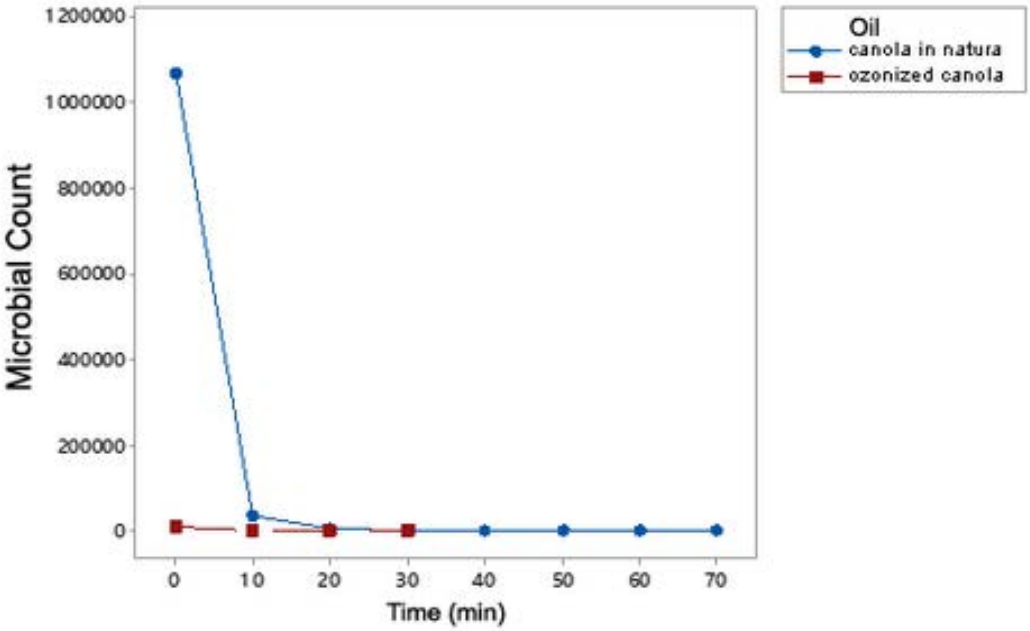

Figure 3. Microbial counts of *Acinetobacter baumannii* for *in natura* and ozonized canola oil according to exposure time.

Figure 4 shows the *Acinetobacter baumannii* microbial count for ozonized and *in natura* coconut oil according to the exposure time. Initially (time zero), an initial bacterial count of 16.10^5 was observed for the ozonized coconut oil. On the other hand, an initial reduction of this bacterium to 10.10^5 was observed for the *in natura* coconut oil. However, after 10 minutes of using both treatments, the inhibition effect is reversed, with the ozonized oil reaching a 1.10^5 inhibition of bacteria, compared to the *in natura* oil (3.10^5 bacteria). The maximum efficiency in controlling bacterial growth was achieved by both oils applied at 40 minutes.

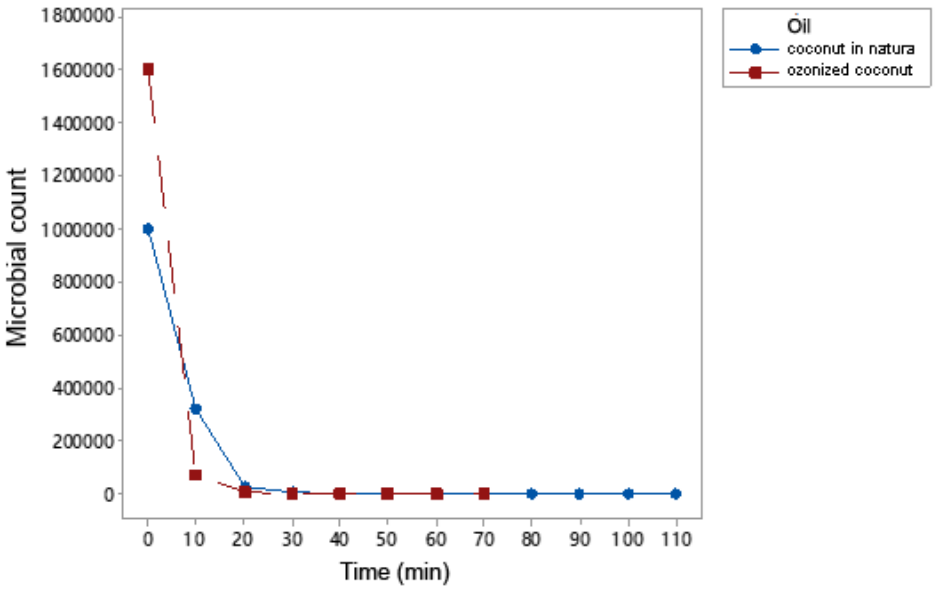

Figure 4. *Acinetobacter baumannii* microbial counts for *in natura* and ozonized coconut oil according to exposure time.

Figure 5 shows the high microbial population for both oil palm, ozonized (13.10^5) and *in natura* (11.10^5). The oil *in natura* extinguished the bacteria at ten minutes, while the ozonized oil allowed the decrease to 1.10^5 of bacteria. At 30 minutes, the maximum inhibition of microbial growth was reached.

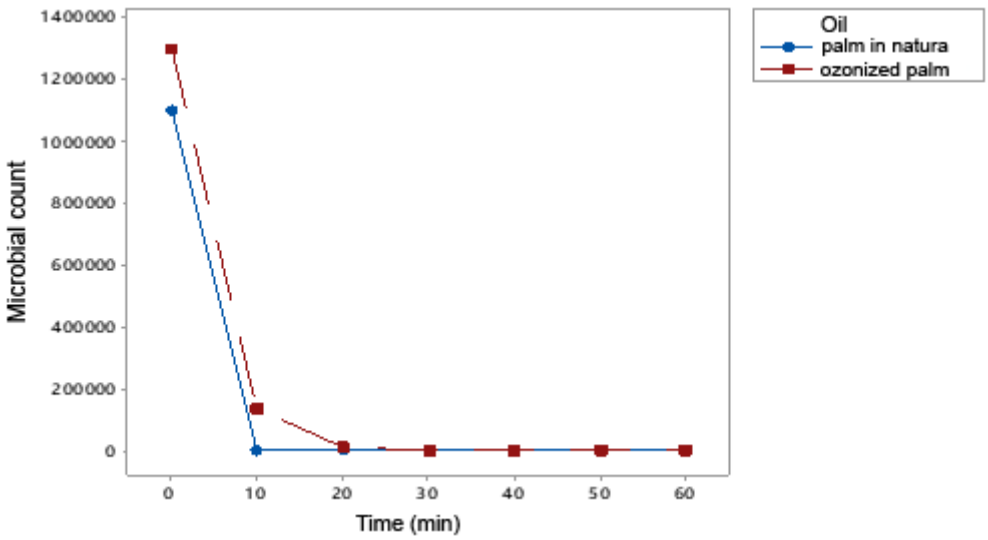

Figure 5. *Acinetobacter baumannii* microbial counts for *in natura* and ozonized palm oil according to exposure time.

Table 3 shows the comparison between the *in natura* and ozonated treatments with a significant difference only in coconut oil (p=0.012). The decrease in the microbial count was significantly higher in the ozonated oil treatment. For the other oils, the ozonated and *in natura* treatments were not significant in decreasing the microbial count (P>0.05).

Table 3. mean ± standard deviation (Median) of the percentage variation (%) of the microbial count in comparison to the natural oils evaluated.

Natural Oils (MBC *in natura*/MBC ozonized)	Treatments		P[1] Value
	in natura	ozonized	
Canola (50%/25%)	-85,5±16,2 (-93,5)	-95,1±5,2 (-96,2)	0,246
Coconut (50%/25%)	-27,4±163,0 (-71,6)	-69,9±66,7 (-93,8)	**0,012**
Palm (50%/12,5%)	-74,7±30,8 (-85,9)	-90,4±6,1 (-91,0)	0,194
P[2] Value	0,058	0,134	

P[1] Value referring to the Mann-Whitney test at P<0.05. P[2] Value refers to the Kruskal-Wallis test at P<0.05.

Figures 6 and 7 show the percentage variation behaviors of the microbial counts according to the ozonated and *in natura* treatments and according to natural oils. The black circles and squares in the Figures indicate the means and medians of the microbial count variation.

Comparing the microbial count variation between ozonized and *in natura* treatments (Figure 6) resulted in a significant difference in coconut oil (P=0.012). Here, the decrease in the microbial count was significantly higher in the ozonated oil treatment. The microbial count reduction compared to *in natura* and ozonized treatments were not significant for the other oils since all P values were greater than 0,05.

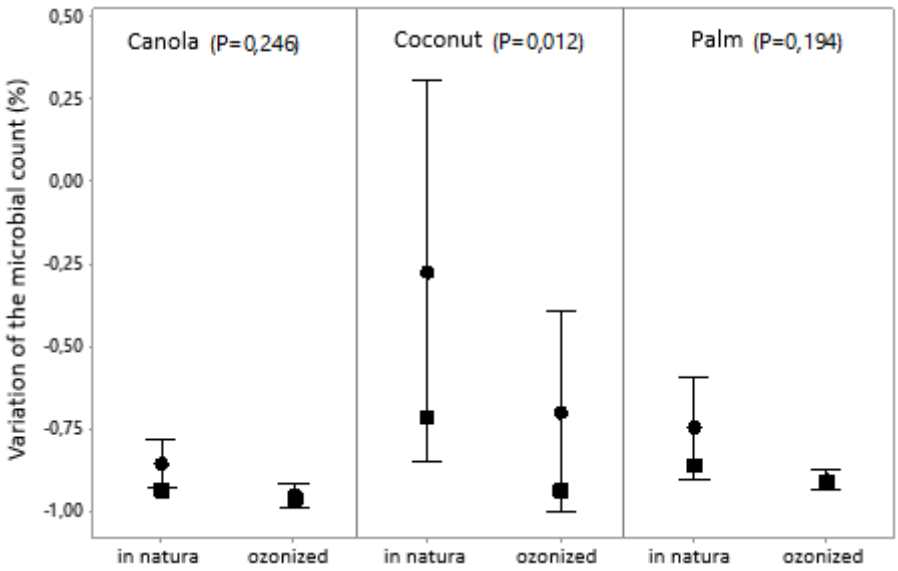

Figure 6. Microbial count percent variation of natural oils according to ozonated treatments and *in natura*.

There was no significant difference when comparing microbial count variation for the different types of natural oils (Figure 7). Despite the absence of a significant difference in the microbial count variation of the *in natura* oils, canola oil showed the greatest decrease in the microbial count (-93.5%), followed by palm oil (-85.9%) and coconut oil (-71.6%). For the ozonized oils, canola oil also exhibited the greatest microbial decrease (-96.2%), followed by coconut oil (-93.8%) and palm oil (-91.0%).

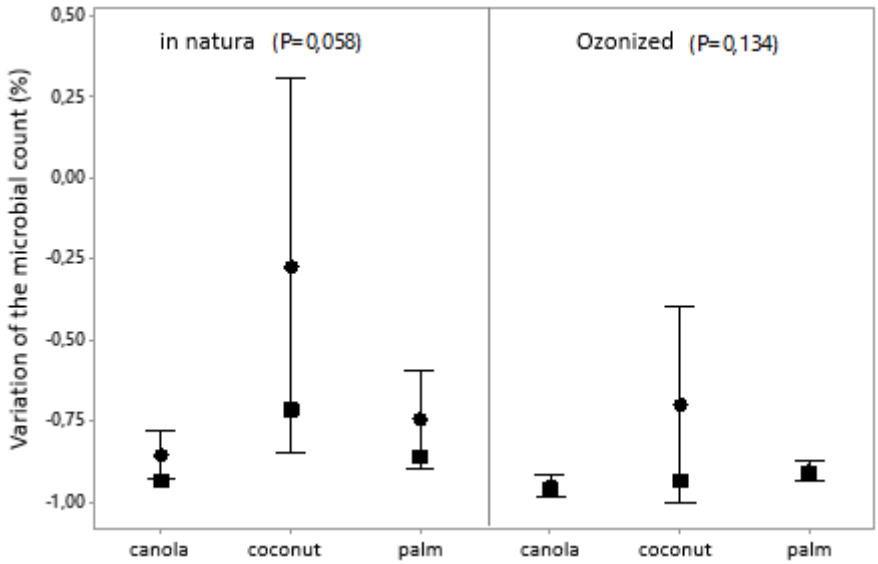

Figure 7. Microbial count percentage variation according to the natural oil type.

The oils properties (palm, coconut, and canola) were also observed, in which the physical-chemical characteristics of the ozonized oils and those without ozone were compared through chromatographic analysis (Figure 8). This Figure shows that palm, coconut, and canola oils that the total fatty acid index for ozonized and non-ozone treatment showed identical results 100g/100g ± 0.02 quantification limits (QL). Also, in the same Figure, the acidity parameter obtained by quantifying the oleic acid was not detectable (less than 0,1 LQ) in both tratment groups.

In Figure 8, the ozonated palm oil density showed a result of 0,892 g/cm^3 ± 0,0002 LQ, while the group without ozone showed values of 0,893 g/cm^3 ± 0,0002 LQ. The analyzed iodine index obtained 51 mgI2/g ± 0,1LQ for the ozonated group, while for the group without ozone, the value found was 55 mgI2/g ± 0,1LQ. The palm oil peroxide index in the ozonated group showed 434,8 mEq/Kg Na2S2O3 ± 0,2 LQ, while it was not possible to detect values for the group without ozone (**ND ± 0,2 LQ). The saponification index of palm oil resulted in 174 mg KOH/g ± 0,1 LQ for the ozonized oil and 186 mg KOH/g ± 0,1 LQ for the one without ozone.

It is observed in coconut oils (Figure 8) that the ozonized group's density observed 0,934 g/cm^3 ± 0,0002 LQ and the group without ozone 0,928 g/cm^3 ± 0,0002 LQ. In the iodine index measurement, the result for ozonated oil was 7,1 mgI2/g ± 0,1LQ, and without ozone was 16,7 mgI2/g ± 0,1LQ. The peroxide index 422,4 mEq/Kg Na2S2O3 ± 0,2 LQ was obtained by the ozonized oil. In contrast, it was impossible to obtain values in the group without ozone (ND ± 0,2 LQ). For the saponification index, a result of 204 mg KOH/g ± 0,1 LQ was obtained for the ozonized oil and 246 mg KOH/g ± 0,1 LQ for the one without ozone.

Canola oils (Figure 8) presents the ozonated oil density was 0,916 g/cm^3 ± 0,0002 LQ and for no ozone was 0,917 g/cm^3 ± 0,0002 LQ. Iodine was observed in ozonated oil with 99,5 mgI2/g ± 0,1 LQ, while without ozone, it showed 110.1 mgI2/g ± 0.1 LQ. The results obtained in the peroxides analysis for the ozonized oil were in the order of 125,7 mEq/kg Na2S2O3 ± 0,2 LQ, in contrast to the group without ozone, whose parameter was not detectable ** ND ± 0 2 LQ. The saponification index for ozonized canola oil was 149,9 mg KOH/g ± 0,1 LQ and no ozone 190,3 mg KOH/g ± 0,1 LQ.

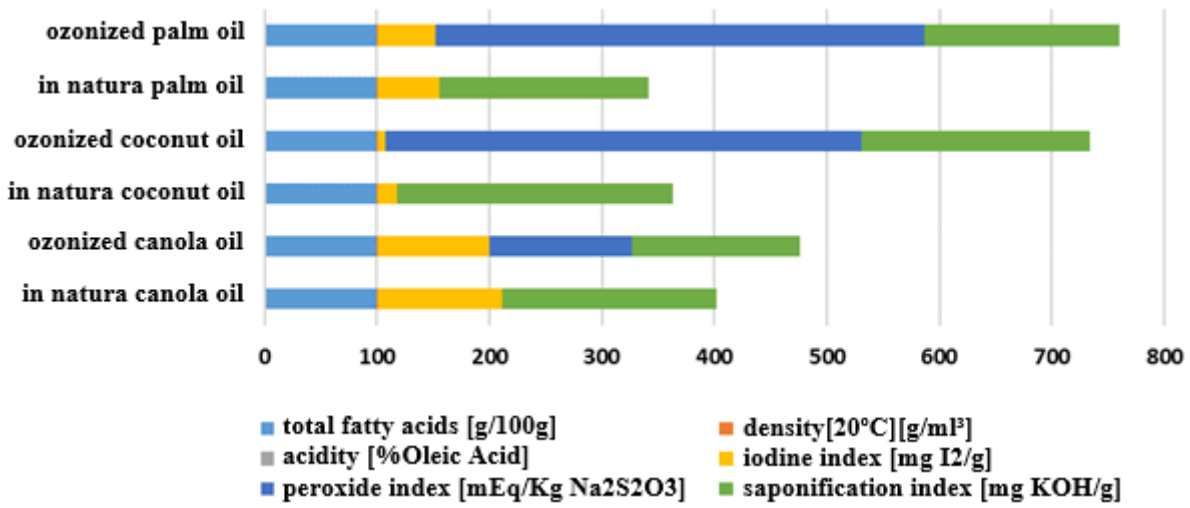

Figure 8. Physicochemical chromatographic differences of natural oils submitted to *in natura* and ozone treatments.

4. Discussion

According to the results (Figures 3 and 4), the microbial count reached zero at earlier times in the ozonated oils when compared to the *in natura* oils. Although there were no significant microbial count differences when comparing the treatments (ozonated and *in natura*), the time to reduce the microbial load to zero was shorter in the ozonated oils. This result indicates that the oil ozonation accelerates microbial

elimination, showing that ozonation has antimicrobial potential. It reached the zero value of microorganisms in shorter times compared to the oil *in natura*. In Figure 5, the microbial reduction time was similar for palm oil.

It is also necessary to consider coconut oil antimicrobial activity (Figure 7) since the ozonation process increased the drop in microbial load from -71,6% (*in natura*) to -93,8% (ozonized). For this oil, ozonation was significantly effective in reducing microbial load.

It is important to emphasize that ozonated and *in natura* oils represent an interesting pharmaceutical approach for treating various human and animal pathologies[25-28].

In some countries, ozonated and *in natura* oils are available for alternative use, characterized as natural and renewable sources, obtained through simple technology, low cost, and broad biological activity with low side effects[29,30].

For more than a century, ozone has been known to be an excellent disinfectant that, however, had to be used for a long time cautiously due to its oxidizing properties. Only in recent decades has it been possible to measure its concentration accurately and permanently incorporate the gas into compounds such as natural oils. Gaseous ozone chemically reacts with unsaturated substrates, leading to therapeutically active ozone derivatives[13,31]. Notably, the pharmacological activity of ozonated oils is dependent on the level of ozonation and the composition of the oil[30,32].

In the oil ozonation process, ozone reacts with carbon-carbon double bonds of unsaturated fatty acids, forming ozonides or 1,2,4-trioxolane rings and peroxides as the primary products responsible for antimicrobial activity and stimulating tissue repair and regeneration properties. Ozonated oils, containing 1,2,4-trioxolane rings formed in an unsaturated fatty acid chain, are considered an active ingredient and a carrier simultaneously, increasing absorption and penetration into the skin[29].

Another relevant consideration is that the ozone antimicrobial properties are due to oxidized compounds, such as hydrogen peroxide, hydroperoxides, aldehydes, and ozonides, formed when polyunsaturated fatty acids present in natural oils come into contact with ozone[33]. In this sense, Captain[34] describes the importance of ozonolysis in different types of oils to discover a broad-spectrum antimicrobial product with greater efficiency for therapeutic purposes. The author points out that the peroxide value should be kept between 300 and 2000 mmol-Equiv/kg. From the results obtained in this research (Figure 8), it was found that the ozonized palm and coconut oils showed values for peroxide 434,8 milliequivalents/kg and 422,4 milliequivalents/kg, respectively, within the recommended range. In comparison, canola oil was lower (125,7 milliequivalents/kg). It should be noted that the ozonized groups showed peroxide formation for all samples, revealing that ozonation promotes the oxidation of grease and causes its deterioration since the values obtained are higher than those recommended by ANVISA[35,36]. Thus, these ozonized oils are incredibly useful in controlling *A. baumannii in vitro*, as observed in Figures 3, 4, and 5.

Similar results were obtained by Hammer et al.[37], when comparing the chemical composition and microbiological activity of ozonized sunflower and olive oils, employing different volumetric methods, liquid chromatography methods, Agar diffusion, microdilution, and macrodilution, for various microorganisms and verified an increase in peroxide and acid values in both oils, being higher in ozonized sunflower oil. The authors state that when peroxide levels are high, ozonized oils have high viscosity,

which hinders access to the iodine bromide reagent's double bonds. For this reason, the iodine value determination is not accurate for this measurement. Of note, in this study, the high peroxide value in ozonated oil was more significant.

Ozone has distinct action mechanisms, depending on the environment where it is applied, being subject to different classifications according to its predominant behavior. Humidity, oxygenation, and temperature significantly affect the ozone action, directly proportional to its effectiveness[38]. As Captain[34] states, since ozonide and peroxide are the main active ingredients, the triozonide is stable and comes into contact with the wound exudate. The same author reports that ozonide and peroxide are the main active ingredients. Triozonide is stable and comes into contact with the wound exudate, generating reactive oxygen species (ROS) and lipid oxidation products. Therefore, this explains the research results, which presented a decrease and zero value of the microbial load (Figure 3, 4, and 5).

Different oils can be ozonated and used for microorganism control; however, olive oil has been one of the most commonly used oils due to its high unsaturated fatty acid content, while coconut oil has high lauric acid and capric acid content. Both oils can heal wounds and reduce infection[39].

Canola oil has been used by Batool et al.[40] for the bactericidal effect evaluation against *Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas aeruginosa, and Klebsiella pneumoniae*. The results showed inhibitory effects of the oil against *Klebsiella pneumoniae, Staphylococcus epidermidis,* and *Pseudomonas aeruginosa*, but no inhibitory effects against *Staphylococcus aureus*. Analogous antibacterial activity effects were observed for ozonated and *in natura* canola oil against *A. baumannii* (Table 3).

In many countries, palm oil is used for therapeutic purposes in traditional medicine practice. All the plant's parts can be used medicinally. The leaves are squeezed, and the juice obtained is applied to wounds to enhance healing. The sap from this plant is also used as a laxative. The fruit peel ash is used for a soap used for skin infections. Powdered roots are added to beverages for the treatment of gonorrhea, menorrhagia, and bronchitis[41,42]. These therapeutic properties were decisive for palm oil choice in the antibacterial activity evaluation against *A. baumannii*.

In the research of Vijayarathna et al.[43], the in vitro palm oil activity against bacterial, fungal, and yeast *C. albicans* strains was investigated. The findings indicated a broad-spectrum activity of the oil extract, which was more effective against Gram-positive bacteria than Gram-negative bacteria. This occurrence can be explained by the fact that the cell envelope structures differ significantly between Gram-positive and Gram-negative bacteria. Gram-negative bacteria have an outer membrane that surrounds the cell wall, restricting the diffusion of hydrophobic compounds through its lipopolysaccharide shell. The cell wall of Gram-positive bacteria with no such membrane can be more easily permeated[44]. Hence, the palm oil extract constituents can hit various molecular targets, including cytoplasmic membrane, proton motive force, electron flow, and cell content coagulation[25,45].

Regarding extracts and coconut oil, *in vitro* studies have identified antimicrobial activity towards *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Enterococcus faecalis, Klebsiella pneumoniae, Proteus vulgaris, Serratia marscens, Salmonella sp, Staphylococcus epidermidis, Micrococcus luteus, Vibrio sp, and Listeria. Monocytogenes*[46,47]. A similar result was observed in Table

3 for ozonated and *in natura* coconut oil against *A. baumannii*, which is evidence of inhibition against this species.

Besides, the extracts and coconut oil's capability to destroy or inhibit Gram-positive and Gram-negative bacteria at low concentrations and minimum contact time establish this plant's secondary metabolites' efficiency as a potential broad-spectrum source of antimicrobial action. For Akinpelu et al.[48], this antimicrobial agent can be used in the treatment of pathogens with multidrug resistance. Another aspect that draws attention through ozone use for clinical therapies is that ozone therapy is also related to skin infection treatment[28], showing that it is possible to use ozone plus natural compounds for microorganism control.

5. Conclusion

It is concluded that the ozonized oils had a more significant reduction in microbial counts when compared to the *in natura* oils; ozonation favored an increase in antimicrobial activity. It is possible to use natural oils (palm, coconut, and canola) to control *A. baumannii*. The palm oil was the most effective in controlling the bacteria, with a MIC of 6,25% and a MBC of 12,5%, requiring 10 minutes for 100% microorganism inactivation.

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DECLARATION OF POTENTIAL CONFLICT OF INTEREST

The authors declare no conflict of interest.

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EFFECTIVENESS OF DEVELOPED WORKSHEETS TO THE ACADEMIC ACHIEVEMENT OF STUDENTS IN SCIENCE 9 CONCEPTS

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ABSTRACT

The study was carried out to evaluate the effectiveness of developed worksheets as an instructional material for teaching specific concepts in science 9. In particular, the aim of the study is to analyze the evaluation ratings of the worksheets produced and the effect of its implementation. It also examines the significant difference between the respondents' academic performances when supported by the developed worksheets. The primary instrument of the study is a standardized evaluation tool for printed materials from the Department of Education, Learning Resources Management and Development System (LRMDS) Office. Results showed that the validated worksheets are identified as appropriate and commendable by the validators. The achievement performance of the respondents has improved substantially. There is a significant difference between the students' academic achievement using established worksheets compared to conventional approaches. In teaching Science 9 concepts, the developed worksheets are appropriate to use as a material and greatly enhanced the students' efficiency.

KEYWORDS: Worksheets; Science 9 Concepts; Academic Achievement

I. INTRODUCTION

Science Education Excellence has long been recognized as a measure of global competitiveness. Developing one's teaching material is an important element to being a successful teacher, as reported by Adipo (2015). The teaching effectiveness of the teacher and the learning of the student is often based on the instructional materials (IMs) used. Muzumdar (2016) noted that there are numerous studies supporting the claim that IMs influence the learning of students. Traditional teaching approaches, according to Özdemir (2010), have a negative impact on the teaching process, particularly in the development of the scientific process skills of students. Suparman (2014) mentioned that worksheets as an educational tool, had proven its usefulness in teaching science concepts, where many claims had made it a productive instrument for providing enjoyment, good motivational activity, learning atmosphere and improving understanding in a non-threatening manner.

Teachers are continuously in the quest for developing new resources to enhance learning in delivering concepts of science. One of these approaches involves the use of non-electronic resources such as worksheets. Azar (2013) emphasized that as a method of teaching science, the Modular Worksheet (MW) approach is the starting point and basis for the development of all critical thinking skills. As tasks were provided with varying degrees of difficulty after the discussion of science principles, the instructional material is a worksheet. Adora (2014) opined that one way of maintaining the interest of the learners is to provide them with activities which they could perform individually after being given the proper guidance, instruction as a teaching tool such as worksheets or module which could make learning interesting.

Notions of Raymond (2000), Torrefranca (2017) and Azar (2013) indicated that worksheets, as a teaching support material, describe the role of teachers as one who encourages the growth of students and offers a facilitative mechanism enabling them to move beyond what they can do. Thereby stimulates the learners to fully execute the activities in order to achieve the learning objectives. Moreover, Vergara (2017) considered the efficacy and acceptability of the learning worksheet, which in his analysis showed a high composite mean that leads to agreeable quality of educational materials.

The researchers tried to fill the gaps by promoting additional concept about worksheets as a productive method to improve the performance of students in a particular concept in science 9 with the current situation and developed worksheet theories as instructional tools. The study also provided an assessment of the effectiveness of the worksheets created, its influence on the pretest and posttest performance of the students.

II. METHODOLOGY

The study used the "design and development" and quasi experimental approach. The "design and development" method was utilized aiming to develop an instructional materials based on an existing theory and get feedback from the performance of students in a particular of research adapted from the study conducted by the Institute of Education Science [IES] (2013) and Özdemir (2016). Also, in measuring the effectiveness of the developed worksheets, quasi experimental scheme was applied. The study has undergone two main Stages. Stage 1 focuses on the evaluation of the developed worksheets by the expert-evaluators from the Department of Education using standardized evaluation tool for printable materials. Stage 2 was focused on the determining the respondents' pretest and posttest performance through the aid of developed worksheets.

III. RESULT

Table 1. Summary Table of the Evaluation Rating of Comic Strips

Area of Assessment	WM	Description
Factor 1: Content	3.90	Very Satisfactory
Factor 2: Format	3.86	Very Satisfactory
Factor 3: Presentation and Organization	3.92	Very Satisfactory
Factor 4: Accuracy and Up-to-datedness of	3.88	Very Satisfactory
Overall Mean	3.89	Very Satisfactory

Table 2. Mean Scores and Standard Deviation value of the Pretest and Posttest

Traditional Legend: 4.00-3.1- Very Satisfactory (VS), 3.00-2.1- Satisfactory (S), 2.00-1.1- Fair, 1.00-Poor				Using Developed Worksheet			
Pre-test		Post-test		Pre -test		Post test	
Mean	SD	Mean	SD	Mean	SD	Mean	SD
7.4	**2.47**	**9.03**	**2.95**	**8.47**	**1.91**	**12.92**	**2.68**

Table 3. T-test for Equality Means

Academic Performance	F-value	p-value	Decision	Conclusion
Control Group Experimental Group	.40	.000	Reject Null Hypothesis	Significant

IV. DISCUSSION

The worksheet was evaluated by different experts using the valuation rating sheet provided by the DepEd-Learning Resource and Development System Office, Division of Surigao del Sur, to assess its effectiveness in terms of content, format, presentation and organization, accuracy and up-to-datedness. Based on the results of the assessment (Ref. Table 1), all products with an average weighted mean of 3.89 are considered to be very satisfactory. The findings indicate that the worksheets produced are sufficient for the level of development of the learner, contribute to the achievement of specific goals, are free of biases and prejudices, promote the growth of creativity and innovation, communication, teamwork, competitiveness, accountability, leadership and responsibility. The overall assessment of its effectiveness showed that the worksheet is highly accessible as an established instructional material in the teaching of basic science 9 concepts. The worksheets have a high degree of acceptability and effectiveness, the expert-evaluators concluded. In a specific definition, the experts considered the content as possible instructional materials to improve the performance of learners.

The pre-test and post-test mean scores of the student respondents and the significant difference in their performance were shown in Tables 2 and 3. The findings showed that the group of students assisted by the worksheets generated performed better than those in the control group. The improvement in their

mean score is an indicator that all the tasks given to them are actually understood and performed well by the students. They demonstrated ultimate interest in the presented concept of science. The findings are reinforced by Estacio (2015) ideas that worksheet facilitates positive classroom engagements and demonstrates a cognitive capacity for the motivation and retention purposes of students. It also agrees with numerous statements from various studies by Naval's (2014) and Aggabao (2014) that worksheets have been found to be successful in the acquisition of information. Therefore, this research indicates that the worksheets produced can be a valuable tool for teaching and studying the concepts of basic science. The findings also show that with the use of the established worksheets and the conventional teaching approach, there is a significant difference between the pre-test and post-test results of the respondents in the teaching science 9 concepts. The result is also supported by the Erkus '(2017) report, which notes that the use of visual and text style presentation gives worksheets the opportunity to get away from conventional classroom delivery modes using traditional method of teaching.

CONCLUSION

Based on the results of the analysis, the researchers concluded that the worksheets produced were successful in teaching basic science 9 concepts as instructional materials. Experts firmly agreed that the instructional content for use in the classroom environment is appropriate and commendable. In addition, the students were able to appreciate the topic in an interesting way through the developed worksheets as the result of increase in their performance. The use of the worksheets produced has served as a good tool as an instructional material. Future research on the creation of another instrument or collection of worksheets is encourage to reinforced in teaching various fields of science and across different disciplines at different grade levels.

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Changes In Hormonal Response Caused By Different Types Of Physical Exercise: A Literature Review

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Abstract

The regular practice of physical exercises brings benefits to health, as long as it is done correctly. Therefore, it is essential to know the type of activity practiced and its relationship with the individual's organism, especially regarding the endocrine response. The objective of this study was to investigate the main hormonal axes that act in physical exercises and to understand their different responses according to the type of activity. A literature search was carried out in the Scielo, PubMed, and VHL databases with the combinations "exercise AND hormones", "sports AND endocrine", "endocrine regulation AND exercise", and "endocrine regulation". After analysis, seven studies were selected for the development of this paper. The physical exercises were divided into two modalities - strength and endurance - which vary according to the homeostatic change imposed on the body. The responses were analyzed according to the acting hormonal axis, as follows: hypophysary, by the action of a hormonal cascade; adrenal, catecholamines and cortisol; and pancreatic, represented by insulin and glucagon. This review revealed the modulation of endocrine responses varies whether the activity is one of strength, which relates to anaerobic processes, or endurance, which interacts with the cardiovascular system. Therefore, it is recommended that further studies be conducted on this subject so that the practice of physical exercises suits each individual's uniqueness and may contribute to the prevention and treatment of diseases.

Keywords: endocrine response; endurance-type activity; GH; prevention of diseases; regular exercise.

1. Introduction

Regular exercise is widely recommended, as it is a protective factor for several cardiovascular diseases, brings benefits to mental health, and maintains a healthy weight. In Brazil, this practice has increased in recent years - in 2019, 30.1% of people aged 18 years or more practiced the recommended level of physical activity, compared to 22.7% in 2013 (Brazilian Institute of Geography and Statistics - IBGE, 2019). In the year 2020, however, this statistic was reduced by the changes arising from the pandemic of the new coronavirus (Sars-CoV-2), so that many Brazilians stopped exercising during this period (Institute of Communication and Scientific Information and Technology in health - Icict/Fiocruz, 2020).

The practice of physical activities must be encouraged among the population as the current situation allows, as long as it is emphasized the importance of professional monitoring to direct the individual to the appropriate practice and thus prevent injuries, dysfunctions or both. Therefore, it is necessary to consider

both the type of exercise and how it relates to the body, especially regarding endocrine responses. Physical exercises may vary according to the energy and physiological demand required from the body, which, consequently, implies in equally varying responses. Thus, it is essential to understand this relationship to guide the individual safely and efficiently.

Thus, given the above, the present study aimed to investigate the main hormonal axes acting during physical exercise, that is, the pituitary, adrenal, and pancreatic axes, as well as to elucidate and understand the differences in the endocrine response according to the type of activity performed.

2. Materials and methods

This is a literature review based on scientific literature accessible in the Scielo, PubMed, and Virtual Health Library (VHL) databases. The inclusion criteria were studies available in Portuguese, English, and Spanish relating physical activity to the endocrine response. Also, it was defined the publication interval between the years 2014 and 2021 so presented only the most recent publications. Various combinations of descriptors were used, such as "exercise AND hormones", "sports AND endocrine", "endocrine regulation AND exercise", and "endocrine regulation". Among all the studies that met the inclusion criteria, seven were selected to be analysed and develop this study.

3. Results and discussion

After reviewing the selected studies, it was chosen to divide them according to the exercise type for a better presentation and discussion of the theme. Aiming to expand the dialogue about the effects, two modalities that encompass distinct modes of activities were segregated: strength and endurance exercises.

3.1. Strength-type activity

Strength sports, such as weightlifting, abruptly change the body's homeostasis due to the intense and fast stimulus. This momentary change between the individual being in inertia and movement contributes to the activation of anaerobic respiration. The energy support is intense in a short time (MOGHETTI et al, 2016). In order to meet the body's need in such sports, hormonal release acts according to the feedback of this high stress. The main hormonal axes to be studied in anaerobic sports are hypothalamus-pituitary, adrenal, and pancreatic.

3.1.1. Hypothalamus-pituitary axis

Within the interval between the beginning and the first minute of activity, there is the stimulation of hypothalamic hormone action, which produces the hormone cascade's central modulators. In the first moment, there is mainly the action of growth hormone-releasing hormone (GHRH) and corticotrophin-releasing hormone (CRH), followed later by the stimulation of thyrotropin-releasing hormone (TRH) and gonadotrophin-releasing hormone (GnRH). This stimulates the production of trophic hormones, which stimulate local areas to produce specific hormones.

GHRH, produced after the onset of exercise, stimulates somatropin production, the growth hormone (GH), in the adenohypophysis. Its increase most significant in anabolic activities and contributes

significantly to performance improvement (CHIKANI et al., 2016). Among the physiological effects caused by this are the stimulation of protein synthesis, lipolysis and glycogenolysis. There is also the production of energy reserves through hepatic gluconeogenesis from the glycerol originated from lipolysis.

Another hormone that increases rapidly after the beginning of activity is CRH, which contributes to the production of adrenocorticotrophic hormone (ACTH) in the adenohypophysis, which stimulates the cortisol production in the cortex of the adrenals. This last hormone varies according to the intensity of physical exercise and the level of stressful activities, i.e., situations that modify the body's homeostasis. Its function is to increase the number of substrates for metabolic use, increasing glycogenolysis, proteolysis, and lipolysis. Moreover, it also contributes to energy reserves production, increasing glycogenolysis, gluconeogenesis, and adipogenesis.

After high-intensity training, there is increased production of TRH, which stimulates the increase of thyroid-stimulating hormone (TSH) in the adenohypophysis, which has the purpose of increasing the amount of T3 and T4 produced in the thyroid. Its main functions are related to cellular metabolism regulation, such as controlling the synthesis or lysis of proteins and lipids, thermogenesis, and stimulating the number of receptors and their affinity to adrenaline.

Finally, the other hormone-stimulated after high-intensity training is GnRH. Its production influences the adenohypophysis to increase the concentration of luteinizing hormone (LH) and follicle-stimulating hormone (FSH), which stimulates the production of sex hormones. In this context, testosterone production is important for muscle anabolism, especially chronically, where it is related to hypertrophy and increased strength. This is supported by the fact that Hooper and collaborators observed a significant increase in basal testosterone rates after five weeks of strength training (HOOPER et al., 2017).

3.1.2. Adrenal axis

In the adrenal axis, the stimulation of catecholamines (noradrenaline and adrenaline) already starts before the beginning of exercise, with the release of noradrenaline generated by the stimulation of sympathetic activity locally, due to the stress caused by anxiety. With this stimulation, the adrenal medulla also produces adrenaline. After the initial moment, there is a high plasma concentration of catecholamines related to the duration and, mainly, the activity's intensity. Anaerobic workouts have the highest concentrations compared to aerobic ones (SELLAMI et al., 2014; HACKNEY et al., 2015).

The effects caused by catecholamines are dependent on the receptors expressed in each organ, but the sets of these actions lead the body to be in a state of alert, whose main characteristics are increased glycogenolysis and gluconeogenesis; inhibition of insulin and stimulation of glucagon; dilation of the vessels of the muscle bed and constriction of mesenteric vessels; and increased heart rate (ANDRADE; de LIRA, 2016). Such physiological actions aim to provide energy support to muscles mainly through glycogenolysis in them and in the liver and increase blood flow so that the nutritional support efficiently reaches the muscles and contributes to increased performance (SELLAMI et al., 2014).

3.1.3. Pancreatic axis

Considering that the sympathetic nervous system's stimulation inhibits the stimulation of the parasympathetic system, physical exercise inhibits insulin secretion since the beta-cells in the pancreas

(where its production occurs) are stimulated mainly by the parasympathetic system and by food ingestion/digestion. Besides, adrenaline and noradrenaline release also acts by reducing its production (ANDRADE; de LIRA, 2016).

Physiologically, the decrease in insulin implies decreased glycogen production and an increase in glycogenolysis and lipolysis. Such effects contribute to glycogen use in the muscles as the significant energy source in strength exercises. Parallel to this, exercise also stimulates the production of another pancreatic hormone, glucagon, which contributes to a significant increase in hepatic and muscle glycogenolysis and lipolysis.

Concurrent to the reduction in insulin levels, there is also a decrease in resistance to this hormone. In this context, anaerobic exercises are better at regulating sensitivity when compared to aerobic exercises or both, even showing more significant reduction of insulin during their execution. A possible explanation for this would be to contribute to the high affinity between receptor and hormone and, consequently, increase the response (BOTEZELLI et al., 2016).

3.2. Endurance-type activity

Endurance physical exercises, characterized by aerobic activities that depend on effective responses in the cardiovascular system, such as running, walking, and cycling, are also responsible for great physiological and metabolic stress. The body's effort to maintain internal conditions in balance generates an endocrine response, which depends on both energy and physiological demands and the intensity of the exercise. Concerning endurance exercises, hormonal changes occur for various physiological reasons that are linked, above all, to the necessary cardiovascular adjustments, the type of predominant fiber in the muscle, energy production, and increased oxygen demand (MOGHETTI et al., 2016).

The excitation of stimulatory, inhibitory secretion or both factors on a gland is part of the cascade of effects of the endocrine system when in a regime of physical exercise, which in the case of the endurance type, has its most relevant responses in the pituitary gland, the adrenals, and the pancreas (HACKNEY et al., 2015). The research around the hormonal changes caused by endurance training and such glands' behavior is of great need since it reveals mechanisms and processes that are useful to adapt training and diets of high-performance athletes such as marathon runners and swimmers, for example.

3.2.1. Pituitary response

One of the fundamental and initial effects of endurance exercise on adeno-pituitary hormone secretion is the stimulation of GHRH to adaptive change. The physiological stress generated has its feedback on the release of GH, which acts on glucose homeostasis, increased utilization of free fatty acids, and regulation of the IGF system (ROSA et al, 2015), responsible for several anabolic processes in the human body and of utmost importance for bone and muscle tissues.

Although there are some differences among the reviewed articles, GH secretion was shown to be lower in endurance exercises when compared to strength exercises. However, there are reports that the combination of both methods lead to more effective acute hormonal responses in anabolic processes (ROSA et al., 2015).

The action of sex hormones during physical activity comes from the release of LH and FSH by the

adenohypophysis, as mentioned before. Such release, however, has a significant dependence on intensity, time, and training methods. Clinical studies describes the decrease in testosterone in high-intensity aerobic activities (HACKNEY et al., 2018). On the other hand, this release in moderate activity is a contributing factor in bone and muscle catabolism.

3.2.2 Adrenal response

The stimulation from ACTH production after physical and psychological stress promotes the release of cortisol by the adrenal cortex. To help the body control homeostasis, cortisol is an essential hormone linked to exercise and sports, with dichotomous effects and dependent on several factors. According to the to the data mentioned above, the intensity of exercise is a determining factor in studying the results of the hormonal dysregulation generated. Particularly in the adrenal glands, the variation in intensity can either stimulate or inhibit secretion. Some studies have considered similar effects to hypercortisolism during simulated workouts. In others, with variations in intensity and methods, the results were a reduction in basal cortisol during resistance exercise (ARRUDA et al., 2013).

Also, in the adrenal axis, the energy supply and the activation of pathways such as glycogenolysis and lipolysis have their feedback in catecholamines. When observing the consequences of this axis's hormonal stress, one should also consider the intensity in endurance exercises, which has been reported only in moderate to strong situations.

The sympathetic nervous system's activation at the onset of exercise is the beginning of the cascade of hormonal responses in the suprarenal medulla. The adrenaline and noradrenaline released in the target tissues induce different energy pathways, such as glucose catabolism, insulin inhibition, and fatty acid utilization (HACKNEY et al., 2015). Among the effects are increased heart rate and output, vascular resistance, and other fight-or-flight type reactions.

3.2.3. Pancreatic response

The adrenergic effect related to endurance exercise plays a vital role in inhibiting insulin secretion by the pancreas. By decreasing blood glucose uptake, peripheral insulin sensitivity is increased, and cells become more responsive to this hormone (ESCRIBANO et al., 2017).

In contrast, prolonged exercise can culminate in a reduction of muscle glycogen and consequent glucose metabolism. The reaction to such a physiological mismatch is the stimulation of glucagon release. Processes such as glucose uptake by the liver, gluconeogenesis, and fatty acid metabolism are part of glucagon's effects in endurance exercise. (HACKNEY et al., 2015).

4. Conclusion

The data found in this review revealed that physical exercises could modulate endocrine responses since they induce changes in the pituitary, pancreatic, and adrenal axes' activity. This occurs due to the physiological stress to which the organism is submitted and the need to adapt. Moreover, this modulation can vary depending on the type of physical demand, strength, or endurance activity. The first type is related to the anaerobic process and fast and intense movements, while the second has a strong interaction with

the cardiovascular system. Thus, there is a need for further studies in this field, not only for exercise to be appropriate according to each individual's body but also so that specific activities can be used in the treatment of metabolic diseases and effectively increased in a preventive manner.

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The roles of student engagement motivations in learning and managing

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Abstract

The purpose of this study is to explore how the combined influence of intrinsic motivation and extrinsic one on the engagement about behavioral, emotional, and cognitive of university students to bring academic achievements. To do this, an experimental questionnaire is designed to collect data from Vietnamese students in Danang and employed Structural Equation Modeling (SEM) to estimate the relationships among proposed variables. The results from 393 samples indicated that intrinsic motivation is the crucial element stimulating their efforts and engagement to obtain learning success. In contrast, extrinsic motivation is found to not bring a positive influence on the cognitive engagement of students. Therefore, this is an important research result that contributes to the theoretical foundation of student engagement as well as makes sense for the management of higher education.

Keywords: Student engagement, Intrinsic motivation, Extrinsic motivation, Behavioral engagement, Academic achievement.

1. Introduction

It is recognized that higher education plays a crucial role in training high-quality human resources, as a foundation for the development of innovation capacity for the development of the country and the contribution of human knowledge. However, the reality shows that universities are facing many difficulties in enrollment due to the international exchange and the outward tendencies of many students. As a result, education managers are still seeking and taking steps to continue to attract new students and maintain current students. Therefore, along with improving the quality of faculty and facilities, grasping students' aspirations to enhance cohesion is an extremely important task of education managers.

The term "engagement" was first explored by Kahn and later it was investigated widely in various disciplines, so a lot of sub-concept of engagement such as consumer engagement (Barger et al., 2016), customer engagement (Quynh 2019), advertising engagement (Malthouse & Calder, 2018), student

engagement (Quynh et al., 2021), audience engagement (Bilda, 2011), online engagement (Quynh et al., 2020b), customer brand engagement (Solem, 2016), civic engagement (Jennings & Stoker, 2004).

Engagement enables service quality enhancement, promotion, customer satisfaction, and competitive advantage (Brodie et al., 2013; Quynh et al., 2020a). Therefore, most businesses including universities, are aiming to initiate strategies to promote customer engagement with businesses. However, what drives the cohesion for each type of business is different.

In the educational settings, the engagement construct is seen as a potential synthetic one (Fredericks et al., 2004) and it is also recognized as a strong predictor element of coming behavior and achievement of students(Klem & Connell, 2004) and is a prerequisite for long-term academic achievement as well as course completion (Connell et al., 1994). In particular, school-attached students are more likely to attend school (Klem & Connell, 2004), test scores better (Willingham, Pollack, and Lewis 2002), score higher (Goodenow 1993) and, have lower dropout rates (Ekstrom, 1986). Furthermore, it is the condition to teachers are more willing to accommodate them with more assistance and motivation (Skinner et al., 2009). Likewise, engaged students showed more positive attitudes and behaviors (pay attention, care more, and be more resilient) than their more relaxed classmates (Klem & Connell, 2004). It is also correlated with behaviors that negatively affect health (e.g., substance abuse, depression, suicide, aggression, premature sexual activity) and aggressive behavior promotes health (eg exercise, nutrition, safe sex) (Carter et al., 2007). In contrast, students who are low interaction levels are highly likely to face top adverse consequences including disruptive behavior and classroom absences, and dropouts (Rodríguez & Conchas 2009). Hence, student engagement has been considered an essential and predictive indicator of learner' motivation and feelings of well-being informal learning environments (Ryan & Deci, 2009). That means highly motivated students will be interested in classes, especially students with intrinsic motivation. To achieve this, the level of student motivation groups must first be identified and the policies that promote student engagement. There have been several studies investigating the extent to which motivation affects student engagement. However, most of the research is done in the developed country context with modern education. Thus, it is necessary to carry out a study in a new context such as universities in Vietnam to have a comprehensive assessment of student psychology.

2. Literature review

2.1. Student engagement

In the education context, student engagement is considered as a new potential meta-construct (Fredericks et al., 2004), is a process facilitating learning (Turner & Patrick, 2004), is a readiness to cohere in school activities with students' cohesion indicators of behavior, cognition, and emotion in specific learning tasks (Chapman, 2003), lead to academic success (Marks, 2000), and is the most promising approach for improving the school dropout phenomenon (Reschly & Christenson, 2006). Another approach, student engagement is also the action energy that connects students and actions (Russell et al. 2005), or the state of positive emotional motivation (Schaufeli et al. 2002) or the initiation of effort, persistence, action with learning, and the emotional state surrounding learning activities (Skinner et al. 1990). Therefore, student engagement could be considered as one of the intangible products of education that are forecast driving

student success. Harboura et al. (2015) proven that there is a positive correlation between student engagement in academic performance and success. That means students who always try their best for learning activities such as completing assignments that teachers require, likely to explore new challenging tasks, actively participating in extracurricular activities, these students often achieve results, expected results as high scores, recognition of society….

2.2. Relationships between engagement and motivations of students

Student engagement level is considered to have a meaningful relationship with student motivation and is a crucial prerequisite leading to the engagement of students during the learning process (Ryan & Deci, 2009). In which, motivation is defined as the individual's energy and motive to study, work efficiently and reach their full potential, and behaviors that are consistent with this energy and motivation (Martin, 2010). In other words, motivation describes to be regarding individuals' effort and time invested in what they are interested in and is higher likely to lead to greater skill and performance (Liem & Martin, 2012). In the educational context, student motivation plays a crucial role in their engagement and academic achievement in school and specific subjects (Martin, 2010). However, some studies have shown that an individual is often motivated to perform a task under the control of two groups of engines, the internal and the external. According to Vivek et al. (2012), when individuals are associated with a brand / product, they are often driven by two groups of motives - internal and external. Most users are boosted by a combination of intrinsic motives (fun and altruism), internalized extrinsic (learning, reputation), and entirely extrinsic motivations (payment, career prospects) (Füller, 2010).

Intrinsic motivation has been viewed as engagement in an activity for the enjoyment, interest, challenge, or natural fulfillment of curiosity (Barry, & King, 2000) or to individuals' instinct to succeed, without obvious external incentives (Reeve et al., 2004). Moreover, according to the goal-orientation theory proposed by Pintrich and Schunk (1996), individuals are intrinsically motivated leading to success-oriented people. Internally motivated students have a high degree of learning achievement and a low level of interest and are engaged more than extrinsically motivated students (Wigfield & Waguer, 2005). In contrast to intrinsic motivation, external motivation is triggered by the intention to achieve the desired results or avoid an undesirable one and is combined with external incentives, e.g. monetary compensation or recognition of others (Hars & Ou, 2002), stickers or point systems when obtaining successful task performance (Williams & Sternberg 2002), and obligations or punishments (Deci & Ryan, 1985). However, such incentives should only be employed when they are relevant to the student's competencies development or to enhance intrinsic motive (Schunk et al., 2002). According to Lepper et al., (2005), when employing external incentives is improper, it can believe that intrinsic ability is better than rewarded and recognized effort. Therefore, it is essential to clarify how external motivation should be structured to enhance internal motive, for example, reward students who are passionate about seeking new challenges and exploring a different learning experience (Lepper et al., 2005). In other words, whereas external motivation describes that individuals exhibit a particular behavior due to external influence elements like the expected rewards or satisfaction of their own ego, the internal motive regards individuals' interest, interest in, or successful instincts (Reeve et al., 2004). The goal-orientation theory tendered individuals are intrinsically stimulated leading to success-oriented people (Pintrich & Schunk, 1996). Saeed and Zyngier (2012) argued that

students who lack motivation show engagement at the rebellious level, authentic engagement belongs to students having an intrinsic motivation, extrinsically motivated students to exhibit passive and ritual engagement. Besides, some authors argue that student motivation derived from internal goals tends to be more resilient, stronger, and easier to maintain than motivations from external coercion (Ryan & Deci 2000, 2001). Likewise, internally motivated students have a high degree of learning achievement and a low level of interest, are engaged more (Wigfield & Waguer, 2005), and have a higher likelihood of seeking out new challenges, exploring and learning, extending and experience their capabilities (Ryan & Deci, 2000) than extrinsically motivated students. Moreover, the efficacy of motivations (intrinsic and extrinsic) not only depends on time and context but a certain activity also (Pintrich & Schunk, 1996). For example, different students can be motivated intrinsically or externally in the same activity (Pintrich & Schunk, 1996). Therefore, it is very important to understand which motive and way its effect on engagement about behavioral, emotional, or/and cognitive of students is an important issue for them to achieve academic success.

A more popular aspect of SE studies is the discovery of the forms of engagement. The previous SE studies show the dominance of three dimensions: behavioral, cognitive, and emotional engagement (Fredricks et al., 2004). Some studies also mention one of these three aspects in their research (Dinsmore et al., 2008; Tsai et al., 2008). Furthermore, a distinct exploration of the forms of engagement – agentic engagement – also has been suggested by Reeve and Tseng (2011). However, it is important to combine all four subtypes of student engagement when seeking how to understand and enhance students' learning engagement (Reeve, 2012). In which, emotional engagement regards the positive emotional response of students derived from experience while learning process, behavioral engagement show students' performance behaviors in pursuit of learning, and cognitive engagement imply the students' mental energy devoting to learning (Fredricks et al., 2004). Another point of view, while emotional engagement is a combination of vitality exhilaration, interest, delectation, hope, gratification, and honor (Pekrun & Linnenbrink-Garcia, 2012), cognitive engagement simply as "students' self-regulation" or employing their " self-regulation strategies" (Wolters & Taylor, 2012, p.641). Further, there is a positive relationship among positive activating emotions (e.g. delectation, hope, and honor), academic outcomes (e.g. academic control, and task-value appraisals), intrinsic motivation (Pekrun et al., 2011), and extrinsic motivation (Putra et al., 2017; Bergström & Garcia Martinez, 2016). Results also demonstrated that the relationship between intrinsic motivations and the cognitive engagement indicators such as learning material elaboration, effort, and self-regulation of learning was positive.

Besides, engagement of students is driven by extrinsic motivations such as awards or social recognization (Lepper et al., 2005; Reeve et al., 2004). Logically, we presume that:

H1: Students' intrinsic motivation positively affect their behavioral engagement

H2: Students' intrinsic motivation positively affect their emotional engagement

H3: Students' intrinsic motivation positively affect their cognitive engagement.

H4: Students' extrinsic motivation positively affect their behavioral engagement

H5: Students' extrinsic motivation positively affect their emotional engagement

H6: Students' extrinsic motivation positively affect their cognitive engagement

H7: Students' behavioral engagement positively affect their achievement

H8: Students' emotional engagement positively affect their achievement

H9: Students' cognitive engagement positively affect their achievement.

3. Methodology

3.1. Measures

The items applied in the current investigation are derived from theoretical inspections on intrinsic and extrinsic motivations (Tremblay et al., 2009; Ryan & Deci, 2000). The student engagement scale gathers items adopted from Fredricks et al.'s (2004) and Tyler & Boelter's (2008) scales. The instrument to measure achievement was adopted from Piedmont (1989) and Hermans (1970). All items considered in the constructs were measured by a 7-point estimation scale ranging from "strongly agree" (7) down to strongly disagree" (1).

3.2. Expected research model

A literature survey related to student engagement motivation was conducted which proposed a conceptual model (Figure 1) indicating some variables and relationships to interpret student psychology and behavior. In this model, intrinsic and extrinsic motivation are considered the premise of motivating student engagement, from that generates their achievement. Survey results will be processed and analyzed based on SPSS 22.0 software and AMOS 20 to calculate the parameters and evaluate the fit of the model shown in Figure 1. To measure parameters for these constructs, their existing scales were reviewed and subsequently modified for use in the educational context.

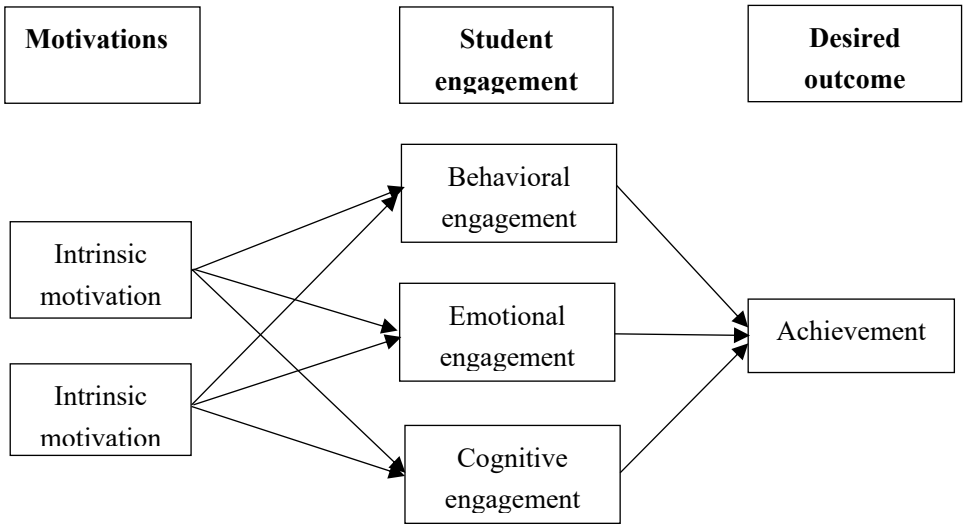

Figure 1. Proposed conceptual framework

3.3. Sample and data collection

There are many groups of drivers that promote engagement, and there are also different sets of outcomes that result from student engagement. However, this study focuses on examining the internal and external motivational groups, and achievement is considered the most expected result from student engagement. In order to ameliorate the accuracy of this study, 428 questionnaires were distributed to students and 415 samples were collected. However, only 393 valid questionnaires were eligible for analysis. Descriptive

characteristics of the candidates are shown in Table 1.

Table 1. Demographic characteristic of respondents

Variable	Catergories	Frequency	%
Gender	Male	135	35.5
	Female	245	64.5
School	Vietnam-Korea University of Infomation and Communication Technology	155	39.4
	The DaNang University of Economics	125	31.8
	Danang University of Science and Technology	100	25.4

As shown in Table 1, while most of the respondents were female, accounted for 64.5% of the sample size, male only captured 35.5%. Among the respondents, 39.4% were students of Vietnam-Korea University of Infomation and Communication Technology, 31.8% were students of The DaNang University of Economics, remain 25.4% were students of Danang University of Science and Technology.

4. Results

4.1. Cronbach Alpha

The research model was tested using SPSS 22.0, in which reliability of the measurement scales in the proposed model has tested applied Coefficient alpha analysis and item-to-total correlations methods (Churchill, 1979). According to the generally accepted rule of thumb (Hair et al., 1998), the item-to-total correlation should exceed 0.5. Although, the research results indicated the high coefficient alphas for the six proposed factors including 0.818 (Achievement); 0.887 (Intrinsic motivation); 0.831 (Emotional engagement), 0.912 (Behavioral engagement), 0.859 (Extrinsic motivation), and 0.855 (Cognitive engagement), four items indicated a low item-to-total correlation. Thus, there was space for improvement. To obtain a higher coefficient alpha and delete low correlations with the total score, several iteration procedures has conducted. As results, the items with low item-to-total correlation such as 'AC1', 'CE3', 'CE5', and 'EE3' were deleted. Leading to desired findings, all the factor loadings are above the threshold of 0.5, coefficient alphas and item-to-total correlations for the revised items ranged from 0.596 to 0.832 and from 0.841 to 0.912, respectively across the six factors implying a reliable measure.

4.2. Measurement model assessment

For reducing and grouping the items of variables, it is essential to conduct an exploratory factor analysis. Besides, to make sure the unidimensionality of the multiple-item structures and test the reliability & validity of the corresponding measurement model, CFA also employed (Bollen 1989).

Table 2. CFA results of the measurement model

Constructs	Number of items		Cronbach's alpha	CR	AVE	Parameter estimate	t-value
	Before analysis	After analysis					
IM	5	5	0.887	0.887	0.612	0.773-0.801	15.813-16.464
EM	5	5	0.859	0.860	0.552	0.668-0.784	13.202-15.317
BE	5	5	0.912	0.913	0.679	0.768-0.881	18.771-22.998
EE	5	4	0.892	0.893	0.675	0.799-0.864	18.815-19.515
CE	7	5	0.841	0.844	0.522	0.673-0.805	11.243-12.744
AC	5	4	0.890	0.892	0.676	0.728-0.907	17.245-21.372
X2/df = 2.264; CFI =0.937 , IFI = 0.938, TLI = 0.929, GFI = 0.880, RMSEA = 0.057							

According to Hair et al. (1998), to test the convergent validity, some indicators including factor loading, construct reliability (CR), and average variance extracted (AVE) should be evaluated. If CR and AVE are greater than 0.70 and 0.50 respectively, and in the total variance AVEs are lower than CRs respectively, convergent validity will be established. Thus, the convergent validities of all six proposed factors will be confirmed. Further, discriminant validity will be established when AVEs are greater than the squared correlation coefficients among factors. As indicated in Table 2, items of each construct obtain a high loading value (0.50 or more), and the AVE of each constitutional concept excees the general level of 0.50, which means each concept is a reliable measurement tool. Besides, to prove the validity of each constitutional concept, it is necessary to examine whether the constituent factors have a unique difference from each other, and also how the concepts have a correlation with external variables. Several common model-fit measures including Cmin/df, CFI, IFI, TLI, GFI, RMSEA, and RMR were employed to estimate the measurement model fit. As shown in Table 3, the fit index of the measurement model X2/df = 2.264; CFI =0.937, IFI = 0.938, TLI = 0.929, GFI = 0.880, RMSEA = 0.057, respectively.

4.3. Construct model assessment

The purpose of the hypotheses test is to determine which predictor variables create a significant contribution to the explained variables. And the satisfied hypotheses with p-values are less than 0.05. To do that, a SEM analysis was also conducted testing the hypotheses of this study. In Table 3, almost all hypotheses were supported with significant p-values.

Table 3. Path analysis results

Hypothesis	Path	Estimate	C.R	p	Results
H_1	IM->BE	0.349	5.45	***	Supported
H_2	IM->EE	0.34	5.399	***	Supported
H_3	IM->CE	0.426	6.058	***	Supported
H_4	EM->BE	0.265	4.24	***	Supported
H_5	EM->EE	0.339	5.441	***	Supported
H_6	EM->CE	0.111	2.445	0.105	Not supported

H_7	BE->AC	0.367	4.874	***	Supported
H_8	EE->AC	0.194	3.745	***	Supported
H_9	CE->AC	0.269	7.152	***	Supported
Note: ***Statistically significant at $p < 0.01$					

The final research results below interpret the confirmation of the hypotheses as follow:

These research outcomes manifest that most proposed relationships are positive significant. Specifically, intrinsic and extrinsic motivations of students to their emotional and behavioral engagement were positively significant with ($\beta = 0.349$, $\beta = 0.34$, $\beta = 0.265$, and $\beta = 0.339$, $p < 0.01$, respectively), hypotheses H1, H2, H4, and H5 were supported. In other words, intrinsic and extrinsic motivations stimulated emotional and behavioral engagement of students. These were in line with the previous studies carried out by Sun and Hsieh (2018), who demonstrated that student engagement was attracted by intrinsic and external factors, furthermore, these results are also accordance with outcomes of Schunk et al. (2012).

In contrast, the cognitive engagement of students was influenced by their intrinsic motivation ($\beta = 0.426$, $p < 0.01$) without extrinsic one ($\beta = 0.111$, $p = 0.105$), hypotheses H3 was supported, H6 did not. This result is believed to be consistent with Wolters & Taylor's (2012) view of cognitive engagement.

As expected, behavioral, emotional and cognitive engagement of students were also significantly related to their academic achievement ($\beta = 0.367$, $\beta = 0.194$, and $\beta = 0.269$, $p < 0.01$, respectively), hypotheses H7, H8 and H9 were accepted. In other words, student engagement creates better learning outcomes. These findings fit with the result of Han et al. (2016) who suggested that engaged students are likely to achieve learning successes.

5. Conclusion

Although there have been some studies exploring the relationship between student motivation and student engagement, there are still some limitations. Therefore, this study aimed to supplement the theoretical background of the student's engagement motivation by providing a few important insights. To do this, this study 1) examines the roles of intrinsic and extrinsic motivations in the university educational context; 2) explores the relationships between student engagement and its desired outcomes; 3) estimates the role of intrinsic and extrinsic motivations in enhancing student engagement. The results show that students' intrinsic and extrinsic motivation positively influences their engagement in the learning process, in turn, engaged students obtained desired successes. This result provides more evidence supporting the results of Saeed & Zyngier (2012) and Lepper et al. (2005). This proves that student engagement is one of the most important premises in determining students' success. Moreover, the products of education services are intangible, which results in the consumption process of producing desired outcomes such as academic achievements, good jobs, meaningful behaviors. Therefore, we expect that, in addition to the efforts of the service provider, the interactive participation of students will create high self-relevance, leading to high cohesion and future behavioral intentions.

Examining the student's engagement from a multidimensional perspective concerning the internal and external motivations of the students facilitates educational administrators including lecturers to understanding deeply about students' personal psychology. Besides, engagement is seen as a malleable,

emotional process that is positively related to student performance or student quality of life (Kahu, 2013). The development of educational institutions framework programs, therefore, also needs special attention to meet the interests, qualifications, and ambitions of students, to help them meet the needs of the labor market. This is an important research result that contributes to the theoretical foundation of student engagement as well as makes sense for the management of higher education.

Furthermore, in this research, we suggested a new research model in order to construct the nomological network regarding SE by considering the motivations driving SE and looking at, at the same time, the relationship of SE with the achievement construct. In other words, the current study not only presents new additions to existing student engagement research but also provides empirical support and validates the outcome of the previous studies. Unexpectedly, the study has also some limitations.

Firstly, the sample employed in the existing study is quite large. Candidates were students of public universities in Danang and all of them were Vietnamese. However, students have often ethno-centrism, leading to may create an unjust or misleading assessment of another cultural pattern (Tilley, 2007). Thus, to generalize more the obtained results, it would be interesting to more investigate whether these impacts remain the same when comparing international with domestic students. Furthermore, it could be worth estimating the moderating effect of demographic factors on these relationships in other educational settings. Secondly, further research should be considered to ameliorate the measurement scales in motivation construct (intrinsic and extrinsic) and student engagement (behavioral, emotional, and cognitive engagement) by combining "engagement at rebellion level" into student engagement construct. This is due to students have the ability to decline activities and general goals of the class, instead, replace some of their own goals (Schlechty, 2001). It would be of significance, thus, to include the concept of "engagement at rebellion level" in the model to a comprehensive assessment of students' psychological when they are driven by different motivational groups. Finally, a new proposal for future research is exploring the reverse path to see which engagement will generate positive motivations for students.

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COOPERATIVE COMMUNITY OF NETWORK LEARNING: experiences of remote teaching in the Technical course of Administration, integrated into High School, from the Instituto Federal de Educação, Ciência e Tecnologia Baiano.

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Abstract

The cooperative community of network application corresponds to practices that increase or compromise and involve two students; therefore, we developed, with this study, a methodology for the creation of working groups from two reports of representatives of the investigated groups. In this sense, the methodological procedures adopted were: descriptive and exploratory research, case study, experience report, documentary, and bibliographic research, with the nature of two qualitative data, derived from the survey with the representatives of the classes of the Technical course in Administration, integrated modality year High School, from Instituto Federal de Educação, Ciência e Tecnologia Baiano – IF Baiano, Teixeira de Freitas – Bahia campus, federal public institution, about or development of non-classroom pedagogical activities. From the results obtained, it is accepted that these activities are divided into synchronous and asynchronous rooms, and that is still in the adaptation phase; also through the experience report suggested to improve communication, the increase in feedback from teachers to students of activities and from students to management on the development of APNPs and difficulties encountered, to promote their effective improvement.

Keywords: engagement; work groups; pedagogical activities.

1. Introduction

In teaching and learning processes, active methodologies can be used, among which students can be understood as the central point. In this sense, it is believed that active learning stimulates the interaction between students, favoring knowledge construction. Network learning appears, then, as a disruptive model in which the student is an active actor in the educational process and can be seen as a link that directs educational practices.

With this experience report, we sought to understand how the Non-Presential Pedagogical Activities were

perceived by the students of the Technical Course of Administration at the Instituto Federal de Educação, Ciência e Tecnologia Baiano – IF Baiano, Teixeira de Freitas, Bahia, Brazil. Adopting the following as a research problem: How can a cooperative network learning community is developed based on non-classroom pedagogical activities with the students of the Technical Course of Administration, an integrated modality to High School, from IF Baiano, Teixeira de Freitas campus? It should be noted that this type of education refers to the combination of High School and Technical Vocational Education.

This study is contextualized, based on Law number 9.394, which establishes the National Education Guidelines and Bases and Resolution 6, September 20, 2012, which defines National Curriculum Guidelines for Technical Professional Education Medium Level.

The choice for the research is justified, the fact that, with the Covid-19 pandemic and after the suspensions of the face-to-face classes, by the Ministry of Education Ordinance number 343, of March 17, 2020, which provides on replacing face-to-face courses with classes on digital media while the New Coronavirus - COVID-19 pandemic situation lasts, the Academic Direction of IF Baiano - Teixeira de Freitas campus, together with the pedagogical, technical team, presented the local community with the Project Remote Activities, which focused on the following aspects: systematizing the work routine of teachers who will develop remote activities with students, ensuring development during the period of social isolation; to structure the monitoring routine of the pedagogical work of the technical-pedagogical team; and organize actions according to the demands arising from remote activities, developed during the period of social isolation.

Given the above, there was an interest in understanding how students received these non-classroom pedagogical activities, hence the personal and social relevance, in obtaining the experience report of the 3 (three) representatives of the classes in the Technical Course in Administration, integrated modality, from IF Baiano, Teixeira de Freitas - Bahia campus, on the development of remote activities, so that it was possible to develop a methodology to implement a cooperative network learning community in the researched classes and, consequently, favor learning.

Thus, as a general objective, we sought to understand how a cooperative network learning community can be developed based on the research carried out, with specific goals, the following: exposing the experience report with remote activities by all classes, of the integrated modality to High School, of the Technical course of Administration at IF Baiano, Teixeira de Freitas campus, in the first semester of 2020; identify whether the subjects' learning objectives and expectations have been achieved; develop a methodology for the creation of study and workgroups, promoting the exercise of leadership by several members and the emergence of spontaneous forms of division of activities and responsibilities to promote the involvement of students and expand their performance in the process of building knowledge.

As a theoretical basis, the concepts of active learning methodology proposed by Bacich and Moran (2018) were adopted, in addition to the literature on learning communities and educational networks, including studies by Morin (2001) that deals with the complexity of education, of Castells (2005) when explaining the network society. Thus, this study was structured as follows: this introduction containing the outline of the research, the theoretical framework with the basis of the study, the methodology with the procedures adopted, the analysis of the data including the experience report itself, the final considerations, and references.

2. Literature review

2.1 Cooperative networked learning communities

Education and cooperation as interrelated social practices are presented by Frantz (2001) as enhancing social processes, which can observe through teaching and learning practices. In this sense, it is essential to highlight the importance of using educational technologies to highlight students' cooperation.

Converging with the precepts of Frantz (2001), the author's Lima, Nunes, and Souza (2020) affirm that an interdisciplinary proposal allows the assimilation of the studied concepts, in addition to developing creativity, as students start to: investigate, think, reflect on everyday problems, facilitating effective learning.

It is believed that the development of cooperative learning communities can increase students' commitment and engagement and the association of diverse knowledge and area of knowledge. According to Silva (2020), it is noteworthy that cooperative is due to a common human need and the awareness of jointly overcoming problems to obtain benefits for those who cooperate.

Thus, cooperative networked learning communities can be understood as a cooperative arrangement, in which different actors, for example, students, try at the same time to meet their demands and allow exchanges between members of the community, to propose and develop innovative practices and actions, effectively obtaining learning about certain programmatic content, that is, it corresponds to the division of activities and generalized discussion of individual and collective knowledge, to have a systemic view of everything that is approached within the community.

According to Morin (2001), education's main task is to train people capable of discovering, inventing, and building new knowledge in an educational perspective that reconnects watertight and fragmented knowledge. Therefore, the development of cooperative networked learning communities is associated, in education, with an active learning methodology.

In convergence, the authors Bacich and Moran (2018) affirm that with the reflection on the theory and practice, the teacher's new positioning comes to exist, reflecting in innovative curricular proposals. Both authors also describe that selecting concepts and methodological proposals allows pointing to learning with different meanings, integrating knowledge with a more global perspective with student-centered learning.

Active learning occurs when one advances in more complex levels of knowledge and competence, according to Bacich and Moran (2018). The active learning methodology can be implemented in the teaching and learning process through problem-based learning or in team learning, which focuses on the need for cooperation between team members, in this case, students who are part of a team. In convergence, Utsumi (2020) presents in his research that a favorable environment for teamwork was created by applying the active methodology, stimulating communication, and leadership.

As people are not obliged to integrate into a specific community, it is believed that individual motivation is of paramount importance, according to Corrêa (2004). Therefore, it is necessary to assign meaning to activities that raise cooperation among students. The authors Magalhães e Silva (2020), in their research, present the need for change in the evaluation process to value the students work, giving meaning to their activities, to make the evaluation process continuous, providing greater engagement of students and their performance in a network of learning and cooperation.

Such cooperation is perceived in work on active methodology by Bacich and Moran (2018) through the following statement that when students have any doubts, they initially turn to group colleagues, thus focusing on an essential pillar of the school's methodology, which is also learning by peers. Then, students resort to an educator's guidance, including using the media channels and internet networks.

According to the author Corrêa (2004), the increasing use of networks such as the internet has resulted in creating a new type of social organization, the network society, which allows the formation of virtual communities, human groups constituted by the identification of common interests. Thus, networks allow people to organize themselves for common purposes, forming groups willing to study. Therefore, the use of the internet as a tool to support networks, process virtuality, and turn it into reality, according to Castells (2007), constitutes the network society itself, which can be considered a starting point for developing a cooperative networked learning community.

3. Methodology

The research on cooperative learning communities in the network was descriptive. It aimed to describe the non-classroom pedagogical activities with the Technical Course students in Administration, an integrated modality to High School, from IF Baiano, Teixeira de Freitas campus. In addition to exploratory research that consisted of a study to familiarize researchers with the object that corresponds to the learning communities, the active methodologies, the networked society, and the applicability of technologies in the educational process.

According to Gil (2007), according to the data collection sources and the research instruments, documentary research was carried out with the normative instructions that suspended classes and determined that classes could be held virtually, during the pandemic, bibliographic research was also carried out, a case study with the researched classes, as well as an experience report on remote teaching.

The sample chosen for the research represented 100% of the universe. It was of a non-random and intentional type, as it sought to identify, together with the 03 (three) representatives of the classes of the Technical Administration course surveyed, which correspond to the total of classes in the 2020.1 semesters, in the modality integrated with high school, their perception of the difficulties experienced by the class with the APNPs, in addition to the students' initiatives to cooperate with the class, interpersonal relationships and collaborative study proposals.

It should be noted that the experience report of the representatives surveyed may not represent the total perception of all students in the classes, which can be understood as a limitation of this work. Still, it is believed that, because they are the representatives and because they have contacts with students, their view may reflect, in part, the view of most students.

The qualitative data were tabulated using a dialogical exposition of the experience report and the presentation of a word cloud that included the main words of the said report. At the end of the data analysis, a methodology for the creation of study and workgroups was presented based on a model suggested by Bacich and Moran (2018) in which they used a synchronous and asynchronous class evaluation and self-evaluation form, which was adapted for the best description of the researched reality and, thus, to answer the research problem. The time cut was December 2020 that corresponded to the end of the first phase of

the application of non-classroom teaching activities.

4. Analysis and Discussion of Results

Initially, how remote activities were developed and how the contact with the classes took place is presented through the experience report described by the representatives of each of the 03 (three) groups surveyed, as follows: before the beginning of non-classroom pedagogical activities, IF Baiano, Teixeira de Freitas campus started remote activities by sending texts and questions to students and then held web conferences through some teachers and with students who voluntarily participated.

Soon after, in a Web conference between leaders and campus coordination, he was informed about the remote activities' beginning. This would be the method adopted for the return of the non-classroom classes. Before that, a questionnaire was prepared to determine the students' availability, if they have access to the internet or/an electronic device to develop the activities, highlighting the management's concern with the students' access to classes. The course coordinators also contacted students who did not answer the questionnaire by phone to identify whether they had access to the internet. The timetable for the core subjects was developed by the corresponding teachers and the Teaching Coordination. The technical core timetable was developed by teachers in the specialized area and the course coordinator.

Thus, a model of non-classroom teaching activity was sent from the rectory to the campus. The campus, in turn, organized some meetings between teachers and students to discuss remote teaching. It is worth mentioning that these meetings were communicated between the class leaders and not through individualized contacts with the students, so it is clear that communication was inefficient. Also, the representatives of the surveyed classes suggested that the Teaching Coordination hold meetings with each class to expose their problems and desires, but what happened was the training for the virtual environments and not to discuss the activities.

Initially, the classes had contact with remote education through platforms such as Teams, RNP, Skype, Google Meet, Moodle. The classes were divided into synchronous (the classes in Web conferences, live) and the asynchronous ones (which made available activities or recorded classes, videos, texts). At first, the classes were quite confused, as there was no explanation of what the classes would be like, in terms of frequency, grades, and activities, for example, causing many students to become discouraged due to the lack of communication between students and sectors responsible for the classes. However, in the initial week, there were meetings to show how virtual environments work.

Given the above, it is clear that in all the researched classes, there was poor communication about remote education, but this is also because it is something new, with little time for planning, in which, during the Covid pandemic, management and teachers had to provide online classes, for which, many had no experience and were not adequately prepared to take them. Added to this, the constant emotional instability that many students have experienced and the lack of equipment and internet network and the new teaching modality caused discomfort.

Also, on a positive note, it should be noted that two commissions related to remote education were created: a commission aimed at collecting data on students and accessing them to virtual environments so that they could attend synchronous classes and perform the activities of asynchronous classes; a second commission

aimed at teacher training, with workshops on Zimbra, Moodle, Web conferences and Microsoft Teams. Both commissions are still active. In this sense, it is recommended to hold feedback meetings to listen to students about developing non-classroom teaching activities.

Regarding the organization of time (synchronous and asynchronous classes) and the strategies adopted by the teachers, it is reported that: class schedules were established with the common core subjects, where there was a class schedule in conference (synchronous), and classes that could be viewed in a certain period (asynchronous). In the same way, it happened with non-common core materials. Many teachers used video lessons, slides, classroom activities and reviews, lectures, readings.

It is noteworthy that the Teaching Coordination did a great job with the division of synchronous and asynchronous classes, as they left the asynchronous ones for the first morning shifts so that the students did not need to start the day with online classes, since it is not a routine like it would be in person and thus having an initial time of the day to dedicate to asynchronous activities. Another positive point that the Teaching Coordination established was that teachers could be comfortable with asynchronous classes, providing them with didactic autonomy and, if they wanted to give just one synchronous class per week, it would be possible, because in general, at each 4 (four) weekly classes, 1 (one) was synchronous and 3 (three) asynchronous. However, depending on the class's pace and the class, the teacher had the autonomy to increase the number of synchronous and reduce the number of asynchronous.

It is essential to emphasize that due to the number of subjects, there was a division in them, considering the workload to be carried out in person. That is, the workload of the subjects was divided into two semesters. Some strategies adopted by the teachers were: the recording of explanatory videos on the subject for the development of past activities, provision of links and files, and the chat for questions related to activities.

As for the teachers, each one followed their dynamics. The positive point is that, together with some teachers, it was possible to change the methodology if it was not working. There was this freedom to apply or not asynchronous classes on different days and times. The negative point is that teachers who did not previously communicate the change in synchronous schedules and who even taught classes in other teachers' asynchronous activities made it impossible to develop a specific activity at a given time.

Regarding colleagues' engagement, it is reported that some students were engaged and others were not for various personal reasons. However, this did not hinder or raise the class's level, since everyone had individual tasks and duties, in addition to the fact that the teachers were aware that students were not attending classes and activities. Although, in the beginning, there was a difficulty, mainly about the use of platforms, as the class was not aware of their functionality.

Another difficulty to get involved was that many people in the class, due to this whole pandemic scenario, had to find a job, so they were often unable to follow synchronous classes, which was very difficult and even led to the locking the course by some students. However, it is clear that it is still an adaptation phase with this new teaching method, and many students have had a quick adaptation, causing less harm to their studies. On the other hand, according to some classmates, who are not achieving good development, in terms of learning, there is a lack of greater monitoring, for example, about the activities that are delivered to teachers, in the sense of having a return, because neither all teachers have given feedback, which is possible with the use of technology in an even more creative way.

Given the above, it is reported that the role of technology in the execution of activities remotely is

fundamental, as, through them, access to classes, research, and seminars are held. Therefore, it is impossible to carry out synchronous activities without a computer, cell phone, and the internet. The student cannot access the activities, communicate with colleagues and servers, much less manage to search, without access to the internet. It should be noted that asynchronous materials and activities will be made available to students without access to the network to accompany the school semester. Still, the sending of such materials has not yet started.

According to Bacich and Moran (2018), inserted in a context guided by constant changes, in addition to the incorporation of technologies and the speed of information, education goes through a reflection. In convergence, Federal Law number 9,394 of December 20, 1996, Law of Directives and Bases of National Education, in which distance learning, using technologies, gained status as an integrated modality to the education system.

In continuation of the exposition of the experience report, the representatives of the researched classes also reported something that could be changed in remote classes and, as a suggestion, informed that the change would focus on the fact that the IF Baiano campus Teixeira de Freitas, in the figures from the Student Assistance Coordination, Teaching Coordination. General Directorate should further inspect their execution, in addition to establishing follow-up actions to identify which students are experiencing many difficulties (financial, psychological, learning) and not only those who do not have access to the internet, but those who have access and have not been able to participate in the teaching activities associated with carrying out the activities effectively.

Another suggestion relates to the punctuation that is treated, by some teachers, as a criterion for the presence of students in the synchronous class, considering that there are students without internet, without energy, and without an electronic device. Also, the way activities are presented to students raises further explanations. Some teachers often do not explain what it is to do or even explain the activity's subject (theoretical content). Thus, it is suggested that teachers make the recording of synchronous classes available for those people who could not attend or who want to review the contents by watching the classes more than once. Finally, it would give at least a five-minute break for the student and even teachers to organize themselves between one class and another. It is noteworthy that some teachers already provide videos of synchronous classes, especially those using the Microsoft Teams Platform.

Thus, it was noticeable that one of the greatest difficulties was adapting to the new class routine, because as it was said, many students started to work, some did not have access to the internet or an electronic device, they did not know some platforms, many times some students they did not succeed due to technical problems, or due to individual problems of lack of esteem or other emotional problems that arose mainly with social isolation, and there was no division of tasks in the classes, so it is reported that each one did their jobs and their activities, there was no study or organization together.

In this sense, there was no combination between colleagues to form the virtual study group around a common interest topic to all. Still, some more intimate people met in other existing groups (which has nothing to do with related things about school) to develop some activities. And nobody took the initiative to moderate the group's activities.

Regarding creating a discussion on an internet provider, it is reported that the classes have a group among themselves on WhatsApp, but it has existed since before the pandemic. A few teachers asked to create an

exclusive group for their subject with the class, also on WhatsApp, and it was done, and that group serves to answer questions and even send materials. However, virtual communication did not dynamize all relationships. A Coexistence Agreement or set of proposals and rules of behavior and group relationship was not established. However, it was possible to perceive a sense of cooperation, especially about the working people, as colleagues who were not working helped what was, so that it could deliver on the scheduled date.

4.1 Methodology for creating a study and working groups

Based on the report of experiences with non-classroom teaching activities, and based on suggestions on improving communication and facilitating development, specifically on the role of students, it is presented that the creation of study and workgroups may facilitate the understanding of asynchronous activities and developing knowledge in a macro way, highlighting the syllabus contents of the various disciplines, exposed in synchronous classes. Therefore, it is necessary to perform some procedures, as shown below.

Initially, for the study and workgroup to be created, it is necessary to gather colleagues, proposed to form the virtual study group, to identify preferences for one group or another, based on the interpersonal relationships that already exist and focusing on diversity, personality, connections between members and their respective values. The second procedure relates to the collective establishment of a Coexistence Agreement to promote the involvement of members in the study group activity in a standardized way, that is, establishing the rules of conduct, in addition to identifying the leader of the group of studies and assign to the functions or areas of each one within the group, in a cooperative and solitary way, based on the content or disciplines of the greater affinity of the members.

The roles of each one must be established, which according to Robbins, Judge and Sobral (2010), the role is a set of expected behavioral patterns attributed to someone in a specific position in a social unit and which is related to the view that one has about how whether to act in a given situation. Thus, according to Universia (2020), when discussing a topic, it is essential to define who will be the moderating members, that is, who will be responsible for guiding the discussion by offering more essential topics on a given topic. Still, regarding the roles, it is suggested: the group leader who will be responsible for controlling the activities to verify if what they planned to do was put into practice, or if adjustments will be necessary, ensuring that the group's activities occur in a timely manner, satisfactory form; the member responsible for communication who will control the delivery dates of the activities and make contact with the teachers and the management, representing the group, also, he will be responsible for establishing a rapprochement with the educational institution; also, each member must contribute to the research and reading of the basic and complementary material indicated by the professors of the disciplines who were taking courses at a given moment and must present a report of the content that was under their responsibility (summary, review, fiche) so that all members of the group have access to the content, guaranteeing support and credibility to the asynchronous activities that will be developed, often individually, and to the dialogued discussions in the synchronous classes.

Then, a discussion list and a schedule of activities should be created so that the group's management is participatory to use the decision-making process collectively, including identifying adjustments that need to be made to achieve the general objective that should be to obtain learning in the disciplines. In the end,

external guests' participation will be allowed, who can be invited according to the group's needs, such as teachers and researchers who can contribute to the solution of doubts on a specific subject or the better targeting of study materials.

It is noteworthy that the study group members, over time, may present behavioral deviations in the environment, as many may experience emotional problems, physical or financial implications that suppress them from participating in the group and developing activities, according to schedule. To minimize this situation, all group members must be aware that they need to value the work of their colleagues and put themselves in a position of cooperation and not of competition to create a positive effect, making the members more predisposed to contribute.

Thus, virtual communication should be valued in the planning of the group's activities, to standardize said communication, and to schedule posts of relevant content consistent with the themes chosen for the study, in addition to understanding the learning difficulties, discussing with the professor of the corresponding discipline, to elaborate collaborative study proposals, favoring the relations of cooperation, exchange and exchanges between all members of the research group. Some applications and websites can be used to create study groups, such as Meetup, GoConqr, and Google Groups. To illustrate the methodology, figure 1 is presented the cycle of actions necessary for creating study groups, essential for dynamization with the students, with a focus on the routing of activities.

Figure 1. Routing for the development of a cooperative networked learning community.

The preferred methodology for the creation of study groups was established based on the needs of the students and on the perceptions of this experience report on positive and negative points, in addition to conducting research with several Statutes and Internal Regulations of Research Groups, information on research groups, studies, such as Lasid (2021), Geedu (2021), Universia (2020), Justen (2014) and Unyleya

(2021). Such methodology can be made available to students through informative and consultative meetings given by teachers and management in favor of the student's adherence to such a solution, focusing on the development with non-classroom teaching activities more efficiently. Also, it can be used by several teaching or research institutions that want to use active methodologies and peer learning when putting into practice the use of study groups.

5. Conclusion

In this sense, it is believed that it is possible to develop a cooperative network learning community, based on non-classroom pedagogical activities with the students of the Technical Course of Administration, an integrated modality to High School, from IF Baiano, Teixeira de Freitas campus, through study and workgroups, as well as improvements in the dynamics of activities, such as: providing feedback to students about non-classroom teaching activities; improving institutional communication by increasing contact with students through periodic meetings; more excellent supervision of the execution of remote classes, so that the timetable is followed according to the schedule presented by the course coordinator; standardize the sequence of sending activity and return, that is, encouraging the teacher to explain the asynchronous activity before sending it to the students and after receiving and correcting the activities, encouraging the teachers to present the correct and incorrect answers in order to clarify the learning objective; develop a teaching manual on remote teaching aimed at students and teachers.

Thus, in view of the adequacy needs that were identified with this experience report, it is believed that not all the learning objectives and expectations of the disciplines were achieved, as many of the didactic methodologies applied by the teachers did not include innovations, such as: o use of games, use of videos, link to complementary material, recording of classes to watch later, the use of PodCast to expose a more specific subject, influencing, including the reception of students.

It should be noted that the adoption of non-classroom teaching activities was significant for the continuity of the Institute's educational activities, teaching activity, and for the way that many teachers are conducting, which reflects the use of active learning methodologies. In this sense, the negative points highlighted in this experience report correspond to the recommendations for adjustments and adaptations with a focus on improving the development of remote classes and, thus, effectively establishing an innovative didactic practice that promotes learning.

Thus, results show that the study and workgroups can favor communication and reduce the challenges that students have faced. For example, it is possible to develop a methodology for creating research and workgroups, promoting the exercise of leadership by several members, and the emergence of spontaneous forms of division of activities and responsibilities to promote the involvement of students and expand their performance in the process of building knowledge. By devolution, it is intended to develop an event to communicate the suggestions of this work to teachers and managers to encourage students to participate in study groups.

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Effect of Students' Attendance on their Academic Performance in Some Engineering Courses at the United Arab Emirates University

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Abstract

The correlation between students' attendance and their final grades was studied by many researchers in many universities across the world in a number of specializations. The aim of this study is to investigate the effect of absence on engineering students' performance in general engineering courses and more specifically in fundamental courses that are provided solely by the Mechanical Engineering Department

since there had been a substantial lack of studies involving them. In order to do so, a sample size of over 8000 students from the United Arab Emirates University UAEU was collaborated for this study with a main objective to conclude whether this relationship is significant or not. The data was generally collected over a period of five years, from 2013 to 2018. From the research conducted, the results showed that, students who do not attend class tend to perform worse on exams in engineering. Furthermore, the correlation between the student's class attendance and student's final grade is noteworthy and there is a strong correlation between them. Equally important, such low students' academic performance reflects negatively to the course learning outcomes.

Keywords: engineering students; United Arab Emirates University; student's Absences; grades; academic performance.

1. Introduction

Attendance has always been considered as one of the key factors for student' success. It is almost true that not only for professionals but also for students that "80% of success is in showing up!" [1]. Nevertheless, is it a definite truth that attendance enhances students' performance? If yes, to what degree? Or is it that its effect is not of a huge significance? Also, does the level of influence change based on the location studied? Or does the type of the course matter? Our efforts were poured into obtaining data to investigate this relationship and we attempted to answer all of these questions throughout this paper.

Attendance and grades have always been strongly attached in the minds of many. This belief was put to the test throughout the years by researchers who were eager to know the answer. Hsu and Plunkett [2] from California State University supported the previous claim after investigating it using students' data in introductory programming courses that were taken from an anonymous university. They concluded that there was a strong correlation between attendance and performance. This result was supported by other researchers such as AbuRuz [3] and Fadelelmoula [4] from the field of medicine. AbuRuz [3] findings were from the Applied Science Private University in Jordan; he reached the same conclusion focusing on the field of Nursing. In respiratory care courses Fadelelmoula [4] also found that attendance is a critical factor in the students' learning journey, but he emphasized that there is a need for further research that includes other factors such as CGPA which can be affecting the students' academic performance as well. In the same later field but at Lahore University in Islamabad, Khalid and Mehmood [5] found similar results that were backed up with 69.4% of the collected votes agreeing that absences reduce students' GPA considerably. Furthermore, researchers like Lukkarinen et al. [6] from Aalto Business University in Finland concluded that out of all the three groups they studied, attendance played a significant role in the performance of students in the second group. Their results were obtained after gathering data from classes where the attendance was not obligated and other factors that could affect the grades were controlled. Likewise, Louis et al. [7] ended up with the same outcome while investigating the results of undergraduate phycology-majored students from Australian universities. However, they added that there was a direct effect of the type of the course in determining the grade along with the attendance. For instance, courses that focuses on psychological theories are linked with better grades than those that discusses statistical

methods. Similarly, Leon [8] and Teixeira [9] both robusted the apparent perception of the relationship between absenteeism and grades' using statistics that was taken from business classes. Leon [8] gathered his information from a Macroeconomics course only, whereas Teixeira [9] did expand the study to include Microeconomics, Mathematics, Calculus, and Statistics which were all taken from the university of Porto, Portugal. In addition, Teixeira [9] went as far as quantifying the effect by stating that nonattendance worsens a student's grade by two points in a grading system that goes from 0 to 20. In spite of that, Leon [8] stated that he did not find enough evidences which conclude that the effect of absences propagates on the student's grade over time. Marburger [10] also supports Leon [8] in the sense of that the chance of getting an incorrect answer in the material covered during the student's absence is drastically higher. Other researches like Jones [11], Alghamdi et al. [12], Gump [13] and Davenport [14] are on board with the common results the previously mentioned studies have got.

On the other hand, Bethune et al. [15] found that the relationship between attendance and grades differ slightly after studying data from 30 students in Microeconomics Principle Course at Barton College, North Carolina. Their records suggested that, rather than the attendance being the best predictor of a student's academic marks, its effect was not of large strength. They agreed that the prior success of students was the strongest indicator of their performance. The findings of Benthune et al. [15] were verified by Caska and Prentice [16], from Dublin Business School, who described the attendance as a moderate predictor with a lesser significance than what is perceived. Their research was done on an intermediate level Statistics class and both researchers expressed in their paper that they were not expecting this result. Along with that, at Laureotian University, Gunn's [17] work with a psychology class also suggested that there was a correlation between attendance and performance with a percentage of 43%, yet the degree of its impact is not that clear due to the ambiguous nature of correlation analysis. Moreover, Guleker and Keci [18] studied two Civil Engineering courses (Engineering Economy and Construction Management) at a private university in Tirana, Albania and reach out to similar results as Gunn, but they would not label the relationship as a cause and effect. Their conclusions stem from the fact that there were students with good attendance standing, yet they failed the course. However, their results do suggest that the higher the number of classes the students' attend, the lower is their chance to earn an unsatisfying grade. Adding to the above, Abdi Aden et al. [19] carried out another research in the department of business and accountancy at Simad University in Somalia and their results somewhat match those of Bethune et al. [15] , Prentice and Caska [16].

Table 1 A sample of relevant literature work

No.	Paper title	Courses/ Department/ University/ Country	Manuscript's Findings
1	Attendance and Grades in Learning Programming Classes [2]	Introductory of programming, Anonymous university	The study found a negative strong impact of absences on the performance of students in both exams and assignments.

2	Does Excessive Absence from Class Lead to Lower Levels of Academic Achievement? [3]	Nursing department, Applied Science Private University, Amman	A negative significant relationship was found between absenteeism and GPA.
3	The impact of class attendance on student performance [4]	Respiratory Care courses, Medicine College, Almaarefa Colleges, Riyadh, Saudi Arabia	The Author found out that attendance is very crucial in learning and he is pro mandating it.
4	Effects of Absenteeism on Students Performance [5]	Nursing department, Lahore University, Islamabad	69.4% of voters agree that absences affect performance.
5	Relationship between class attendance and student performance [6]	Aalta University of Business, Finland	There is a significant relationship between attendance and performance were the increase of one result in the betterment of the other, but other factors affecting the performance are controlled. Note: The study was done on a class where the attendance was not mandatory.
6	Teaching psychology in Australia: Does class attendance matter for performance? [7]	Psychology department, Australia	It showed that there is a strong relationship between attendance and final grades.
7	The Relation between Absences and Grades: A Statistical Analysis 18 February 2018 [8]	Microeconomics, Macroeconomics, Mathematics, Calculus, and Statistics	It concluded that a unit increase in normalized absences records results in 0.814 units decline in the mean grade of the class.
8	The impact of class absenteeism on undergraduates' academic performance [9]	Macroeconomics course, University of Porto, Portugal	The findings suggest an inverse relationship between absenteeism and grades. It showed that absences do lessens the students' final mark (around 2 points in a 0-20-point grading scheme).
9	Absenteeism and Undergraduate Exam Performance [10]	Microeconomics Course	Both attendance and performance are significantly correlated.

10	Interaction of Absences and Grades in a College Course [11]	Psychology	Absences were inversely correlated with performance.
11	Prevalence, Causes and Impacts of Absenteeism among Medical Students at UQU [12]	Medicine, Umm Al Qura University, Saudi Arabia	The results show the negative relationship between absenteeism and grades.
12	The Cost of Cutting Class: Attendance as a Predictor of Success [13]	General education course, Mid-Western State University	There is a negative inverse relationship between absences and final grades.
13	A Study of the Relationship between Attendance and Grades of Three Business Law Classes at Broome Community College [14]	Business law classes, Broome community college	There is a significant positive correlation between the attendance and academic performance. The outcome of the study indicates a strong influence.
14	Attendance, Grades and Learning in the Microeconomic Principle Course [15]	Microeconomics Principle Course, Barton College, North Carolina	Prior success was found to be the best indicator of the grades and attendance was not on that level. The effect is said to be moderate but important.
15	Assessments, appraisals, attributes and attendance: Predicting statistics goals and grades [16]	Intermediate statistics class, Business department, Irish College	The study found that attendance was not a very strong predictor of grades. The author suggest that it is of a moderate effect.
16	A correlation between attendance and grades in a first-year psychology class [17]	Psychology Department, Laurcntian University	It was found that there is a correlation and it is significant. The more the classes the students attended, the higher their grade became. Also, it was found that 43% is the percentage the attendance plays in the final grade of the student. The influence is said to be moderate since the degree of effect is ambiguous.

17	The Effect of Attendance on Academic Performance [18]	Engineering Economy and Construction Management, Civil engineering department, Private University, Albania	The outcomes suggested that the relationship was not a cause and effect. The effect is closer to moderate rather than strong.
18	The Effect of Student's Attendance on Academic Performance: a Case Study at Simad University Mogadishu [19]	Faculty of Business and Accountancy, Simad University, Mogadishu	There is a positive relationship between student attendance and academic performance. Its strength is moderate.
19	Class Attendance in College: a Meta- Analytic View of the Relationship of Class Attendance with Grades and Students Characteristics [20]	Course/ Department State University of New York, Albany	It was found that there was a solid correlation (0.5) between the two. The conclusion suggests a strong effect.
20	Effect of Class Absenteeism on Grade Performance: A Probabilistic Neural Net (PNN) based GA trained model [21]	Structural system courses,	The paper states that they are strongly correlated and the attendance in the first phase is the one with the most importance.

Table 1 summarize samples of the relevant published manuscripts, the university/department and the place at which the study was conducted, the courses considered, the effect level of absence on the academic performance and a brief finding of the study.

Finally, it was unexpected that most of the studies were done on students enrolled in specific classes, namely business, psychology and medical classes. It is obvious that the researches made on engineering courses are very lacking. So since mechanical engineering is one of the most important majors nowadays especially with the current developments experienced here in the United Arab Emirates, we thought it would be interesting to know how much of an effect the attendance plays on the students' grades.

In the light of the above literature. It is worth mentioning here that and, student absence is not restricted to gulf region only but it is independent of the place. The same study was conducted in different regions and areas globally like in Europe [4, 6, 16, 19], Australia [7], North America [2, 15], and Africa [19] and had extracted similar results. Thus, Absence is not confined to a certain country or region, but instead, is a worldwide phenomenon and is mostly dependent on the nature of the course. The main goal of this work is to convey the importance of the class attendance to UAEU students, which has direct effect on the course learning outcomes, not to change the university's policy.

2. Methodology and Frame Work

The participants of the study were strictly engineering students enrolled in general engineering courses, namely Calculus 1 for Engineering (MATH 1110) and Engineering Economics (GENG 315). Furthermore, the study included shared courses that were taught to Mechanical, Architectural and Civil Engineering students, these are Statics (CIVL 240) and Mechanics of Material (MECH 305). Strictly Mechanical Engineering courses were included as well, namely Manufacturing Process (MECH 306), Dynamics (MECH 310), Applied Thermodynamics (MECH 311), Mathematics for Mechanical Engineers (MECH 384) and Machine Design I (MECH 407). Table 2 presents these courses (30 classes). This, in addition, comprised some summer courses (e.g., Engineering Economics and Mechanics of Material). The percentage of absence per student during a full course of 15 weeks were obtained over a period of five years, from fall 2013 to spring 2018. It is worth mentioning here that, the total number of students involved in this study was 8000.

Table 2 Chosen courses and their description

No	Course	Course Description
1	Calculus 1 for Engineering (MATH 1110)	Engineering college requirement course.
2	Engineering Economics (GENG 315)	General engineering common course.
3	Manufacturing Process (MECH 306)	Mechanical Engineering course
4	Dynamics (MECH 310)	Mechanical Engineering course
6	Applied Thermodynamics (MECH 311)	Mechanical Engineering course
7	Mathematics for Mechanical Engineers (MECH 384)	Mechanical Engineering course
8	Machine Design I (MECH 407)	Mechanical Engineering course
9	Statics (CIVL 240)	Civil and mechanical engineering course.
10	Mechanics of Material (MECH 305)	Civil and mechanical engineering course.

After collecting the data, the percentage of absence with respect to the dismissal policy of United Arab Emirates University of each student was calculated using the formula illustrated below:

% Absences regarding dismissal = (% Absence in a full course / 15%) * 100

The 15% is set by the university's attendance guidelines as a threshold for course dismissal. However, the faculty member can still feed the absence of the student even after it exceeds 15%. Thus, some of the data in the graphs below are above 100%.

The data were further investigated and analysed by calculating their mean and standard deviation. Then, graphs were formulated from the analysis which is where our conclusions stem from. It is also worth mentioning that the common courses between the engineering departments consisted of a sample size of

around 8000 students in total whereas the courses that were specifically meant for Mechanical Engineers were significantly smaller with a cluster that contained around 20-60 student per course.

It is worth noting here that, the study has been conducted to investigate if the student's class absence/attendance has an impact on the student academic performance regardless of the Socioeconomic status (SES), ethnicity and age. In this study, a variety of engineering courses, e.g., mechanical engineering courses and common/fundamental courses that are studied by students of other engineering departments.

3. Results and Discussion

The results of our study were summarized in the format of bar charts due to their clarity and simplicity which allows for anyone to extract their own conclusions. They basically represent the averaged percentage of absence of students per grade (ranging from A, A-, …, F). By taking a glance at the charts, it is noticed that the higher the sample size for the studied courses (Engineering Economics (GENG 315), Mechanics of Material (MECH 305), Calculus I for Engineering (MATH 1110), and Statics (CIVL 240)), the more the results show clearness and consistency in the trends throughout the grade scale. However, when the sample size was smaller like in Manufacturing Process (MECH 306), Applied Thermodynamics (MECH 311), and Mathematic for Mechanical Engineers (MECH 384), the effect of prior success, online tutorials, self-learning and another external factor got emphasized. Yet two courses skewed from this effect even with a smaller sample size such as Machine Design I (MECH 407) and Dynamics (MECH 310). Reasons and assumptions behind this will be discussed later.

Most of the outcomes that were obtained supported the proposed claim which was "the higher the absences of a student, the lower his/her grade became." These findings add robustness to the claim proposed by Hsu and Plunkett [2], AbuRuz [3], and many other researchers who believed in the importance of attendance for the process of learning. Not only that, the fact that this claim was supported by data that was strictly taken from engineering courses imply that absence can be catastrophic specifically in general courses which work as a foundation for all the knowledge that comes afterward.

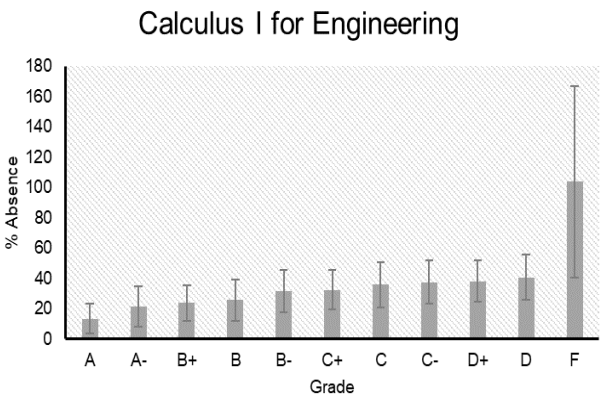

Figure 1. Calculus for Eng. (MATH 1110)

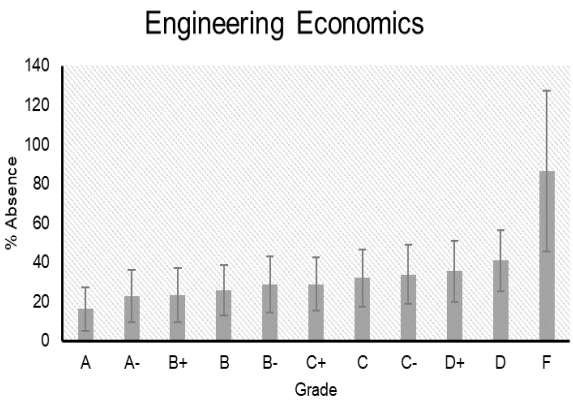

Figure 2. Engineering Economics (GENG 315)

Figure 1 and 2 are for two of the general engineering courses that all engineering students have to take regardless of their associated department. As it was mentioned before, there is a clear increase in the

percentage of average absence as the grade gets lower. Going from 10% absences to 40 % absences, in almost both courses, the grade is lowered from A to D (or F). This is partly due to the absence in the lectures of those courses and missing the discussion, and also due to the current GPA and previous knowledge of the students of the related topics, and the motivation the students have to study those courses. Even though the standard deviation represented by the error bars show a similar trend, it still apparent that there were some data that were further away from the average value and can be considered as outliers. For instance, by looking at the percentage of absence in the F grade in MATH 1110, it is clear that some students got a failing grade with less than 15% worth of absences! (less than 100% Absence in the diagrams). This can be explained by either the lack of motivation to study by the students or that the instructor was not able to explain the course well. However, these outliers were not as frequent and can be disregarded. This comes from the fact that the standard deviation of the other grades is drastically lower. Also, if the highest and the lowest grades were compared for these figures, it would be quite obvious that the difference between the absences is very distinctive and suggest that such courses require commitment in attending lectures in order for the students' grades to be good.

This is probably due to the fact that usually freshmen students are the vast majority of these classes, and they lack the knowledge and the correct strategies of studying which necessitate the assistance of a professor to give them guidance. It is obvious, however, that if the % Absences is more than 100% this means the student grade is (FA) failure due to absence. As for the shared courses with the Civil and Architectural department represented in figure 3 (CIVL 240) and 4 (MECH 305), the charts demonstrate a very similar rise in the absences on the grade scale relative to the previous ones discussed above. Additionally, the deviation of the data from the average value is still low which imply that the data are not as scattered and relatively consistent. For the Statics course, as the absence increased from 10% to 40% the grades were lowered from A to D; where F grade is related to 60% absences or higher. For the Mechanics of Materials course, it is similar to the Calculus course; 40% absences may lead to D or F grade. It is important to note that the sample size for the mentioned courses was by far the largest, so the conclusions obtained from them are more concrete.

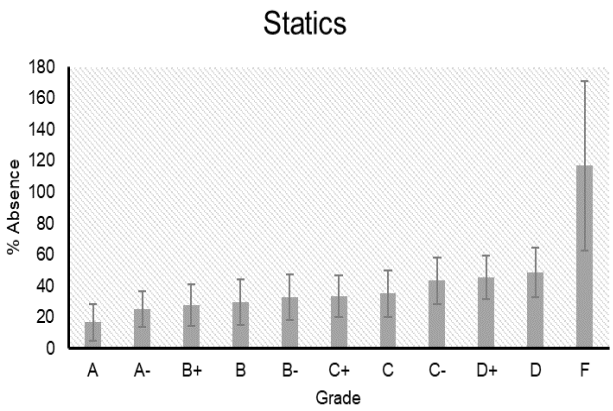

Figure 3. Statics (CIVL 240)

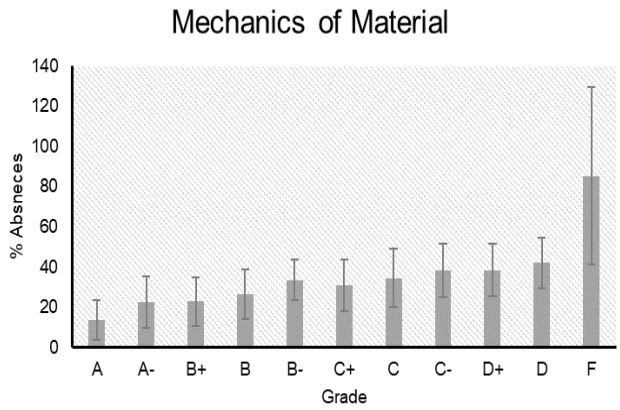

Figure 4. Mechanics of Material (MECH 305)

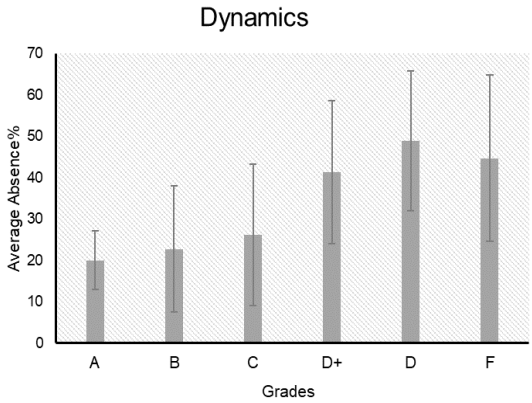

Figure 5. Dynamics (MECH 310)

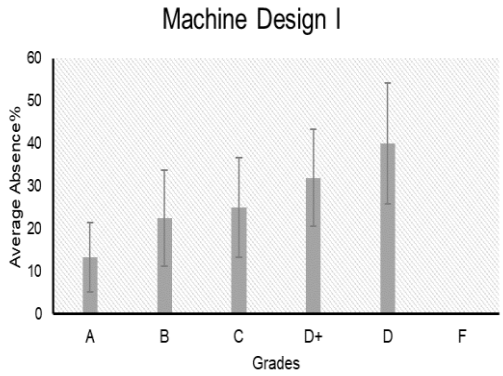

Figure 6. Machine Design I (MECH

As for the Mechanical engineering courses in figures 5 and 6, Dynamics (MECH 310) and Machine Design I (MECH 407) exhibit a similar general trend with a gradual increase accompanied with a decrease between the absences and grades. For the Dynamics course, going from 20% to 50% absences, the grades were lowered from A to D. This can be attributed to the fact that these courses' content cannot be comprehended solely using textbooks or through the students' efforts. So even though the sample size is relatively smaller than the previous data, it still supports the proposed claim that was verified before. Nonetheless, the standard deviation of the data for Machine Design I (MECH 407) is clearly smaller than the Dynamics (MECH 310), which corresponds to a better accuracy for the results obtained from them. This is assumed to be attributed to the nature of the Machine Design course since it includes new Mechanical Engineering concepts that have not been discussed in other courses such as V-belt design, shaft design, power screws and many other topics that the student will be exposed to for the first time.

For the Machine Design-1 course, as the absence increased from 10% to 40%, the grade is lowered from A to D. Any further increase above about 12% absence the grade is lowered than A to any other grade, due to the reason explained before. As for Dynamics, the students do have a prior knowledge of the material through previous physics courses required by the college for all engineering students. This is why some of the students who scored A, have had an absence of 10% or even 20%, as they have prior knowledge of the subjects.

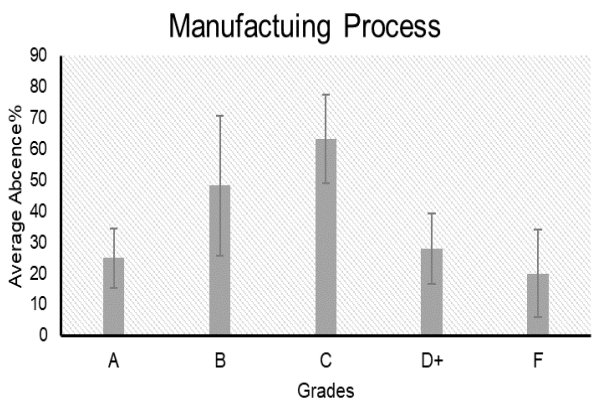

Figure 7. Manufacturing Process (MECH 306)

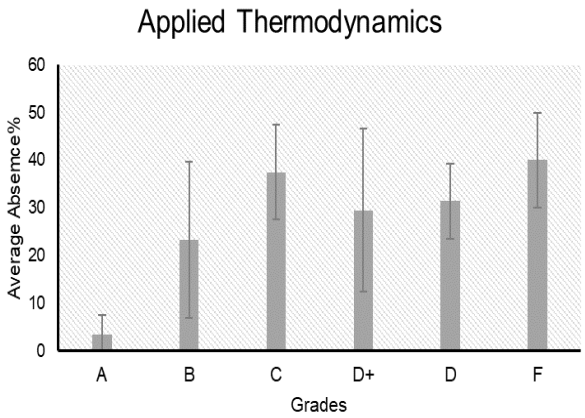

Figure 8. Applied Thermodynamics (MECH 311)

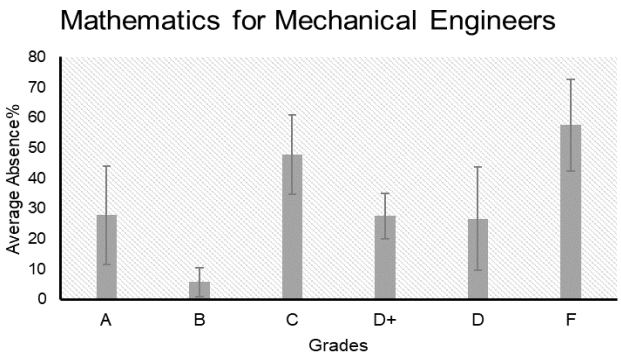

Figure 9. Mathematics for Mechanical Engineers (MECH 384)

On the other hand, Manufacturing Process (MECH 306), Applied Thermodynamics (MECH 311) and Mathematics for Mechanical Engineering (MECH 384) demonstrated in figures 7, 8, and 9, present a higher level of fluctuation in the marks versus the absence percentage. This is applied for the standard deviation of the data as well and that reduces the credibility of the outcomes extracted from these figures since the trend is not coherent nor logical. Also, there is a noticeable variation in the grades B, C, and D. This is most likely to be caused by the insufficient amount of data for these courses. Another reason can be that their contents can be self-taught by the students themselves. For example, MECH 311 and MECH 384 are basically simplified extensions of the courses Thermodynamics (GENG 220) and Differential Equations for Engineering (MATH 2210). As for MECH 306, it is based on manufacturing processes that are of a conventional type that are well studied worldwide and can be explained entirely by textbooks. However, this can also illustrate that, the attendance is not the best representation of a student's performance and other factors like the current GPA and students previous background knowledge may have had an influence just like what was concluded by other researchers like Bethune et al. [15] and Gunn [17], yet that is not very likely since the bigger sample size presented a clearer conclusion. For Applied Thermodynamics and Mathematics for Mechanical Engineers courses, the highest absence is related to the lowest grade.

Moreover, our findings from this study can be superimposed on the results of a number of papers mentioned before. In figure 10, Lukkarinen et. Al [6] showed how the second and third groups are supporting our conclusions. The people with the highest numbers of attendances obtained the highest marks. Also, Leon

[8] and Guleker et. al [18] in figures 11 and 12 respectively, display a scatter plot which shows a decrease of the grade as the percentage of absence increases.

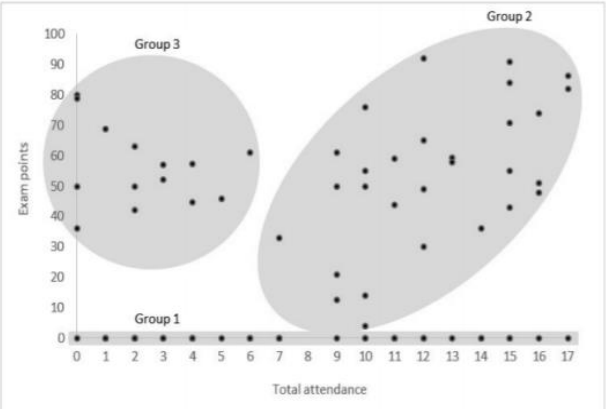

Figure 10. Relationship between class attendance and student performance, Procedia - Social and Behavioral Sciences (Sample Results)

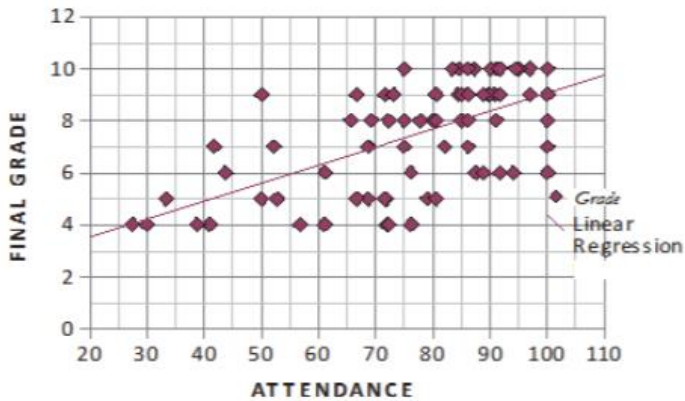

Figure 11. The Relation between Absences and Grades: A Statistical Analysis, MPRA Paper (Sample Results)

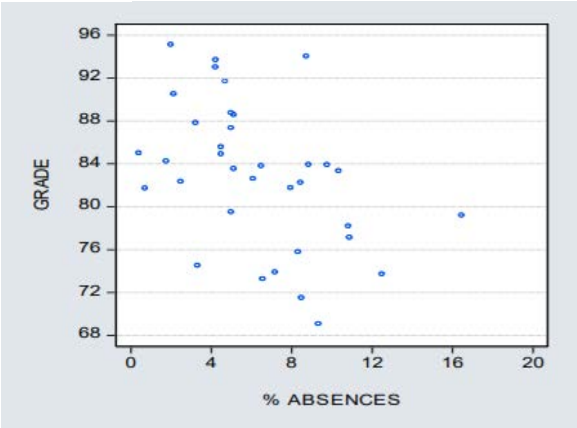

Figure 12. The Effect of Attendance on Academic Performance (Sample Results)

4. Conclusion

In conclusion, this paper aimed to examine the validity of the proposition in the engineering field which states that a student's performance is highly dependent on his/her attendance of classes and lectures. This was done by collecting a sample size of over 8000 students form United Arab Emirates University and extracting information that either supports or negates the claim. At the end, the claim was strongly backed by the data and it became clear that attendance is highly advised for all engineering students which has a crucial effect of the course learning effect and course assessment.

However, there is a need to address the limitations of this study before it is used as a bases for further researches. Firstly, the fact that gender nor age was regarded during the collection of data, the data were combined together in terms of grades only. Also, the availability of online courses, self-motivation, and students' previous success were ruled out due to the large number of data examined through this study do suggest that they contribute to the overall performance of the students.

Response: Foremost, we would like to bring to editor and reviewer attention that, the findings of this study are important for students and teachers alike. The results may be utilized as a motivator for students to attend classes and for teachers to keep in mind the significance of class attendance for course learning outcomes and course assessment alike. For student who cannot or do not wish to attend classes, independent learning may be possible. However, this, indeed, depends on the specific course in question and necessitates substantial maturity, planning, and considerable search for information. This shows the importance of the study. To the best of our knowledge, this study has not been done before in the UAE. The text (abstract, conclusions, and results and discuss section) has been revised to address this point.

5. Declarations:

Funding

Not Applicable

Conflicts of interest/Competing interests

None

Data transparency

Not Applicable

Code availability

Not Applicable

Ethics approval

The manuscript was proofread for the data used and found no errors or ethical wrong.

Consent to participate

Not Applicable

Consent for publication

Not Applicable

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Corona Virus Pandemic and Social Isolation Process Influences on Increased Violence Against Women: an integrative review

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Abstract

Introduction: violence against women is a complex worldwide health problem due to its multicausality. Global background alterations resulting from Corona Virus (Sars-Cov 2) pandemic implicated on the exacerbation of many vulnerabilities, including those that predispose domestic violence. Nowadays this kind of violence is even more intense and reaches significant national and worldwide morbimortality proportions among women. Objectives: to synthetize data described in the literature regarding how the

Covid-19 pandemic and social isolation process have affected women lives concerning domestic violence. Methodology: integrative literature review, using a high sensitivity search in the databases Pubmed, Cochrane, Embase and the Virtual Library of Health (VLH) on Dec 07 2020. Ten studies were included in this review. Results: 90% of the studies analyzed presented an increase in intensity and frequency of violence against women after the beginning of social distancing policies. Women that had already suffered any kind of violence before the beginning of the isolation policies are more propense to physical violence during reclusion. Pandemic reduced contact of these women with their informal support network and with health services, culminating in the enhancement of the gravity of cases that are assisted by the system. Conclusion: women are a highly vulnerable population to violence during the pandemic period. Public policies that qualify professionals and facilitate prevention, tracking and intervention of cases are even more necessary.

Keywords: Women; Violence against women; Domestic violence; Gender violence; Corona virus infection;

1. Introduction

Violence against women is considered a global epidemy and a violation of human rights (OPAS, 2017). It is defined by the American States Organization as any action that, based on gender, causes suffering, death, physical, sexual or psychological damage (TJES, 2020).

It is subdivided into five categories: physical violence, when there is harm to a woman's body by use of physical force or objects by the aggressor; psychological violence, when involves emotion harm, by intimidation or women self-esteem diminishment; sexual violence, when women are forced to witness, maintain or participate in any kind of sexual action against her will; patrimonial violence, involves retention, total or partial destruction or subtraction of any woman's item or object, including work tools, documents, money and others; moral violence, when any allegation is pejorative or falsely held, exposing the victim to calumnies, defamation or injury (TJES, 2020).

Physical and sexual violence are the most notified. In the whole world, one third of women have reported some physical or sexual violence from their partners and 38% of feminicides occur in this context. The variables that most influence the occurrence of domestic violence are stressful environments and conflict situations, low educational level, violence background, disagreement and marital dissatisfaction (OPAS, 2017).

On March 11th, 2020 Sars-Cov 2 contamination, responsible for the popularly known Covid-19, was elevated to a Pandemic category by the Word Health Organization (WHO). All governments were called to take emergency measures to control dissemination and contamination by this virus. The best way to control Covid-19 spread was social isolation, according to the WHO recommendation. This measure changed social organizations and all kinds of spheres in human relationship: interactivity, business, education, health actions. Workers' organization was reconfigured to adequate itself to the historical moment. However, inside the houses, women began to deal with many issues, such as factors that contribute to and enhance domestic violence (WHO, 2020).

In accordance to the WHO (2020), health reports of many countries, including the United States of

America, United Kingdom, China and others, demonstrated a significant increase of violence against women during the pandemic. Furthermore, feminicide cases increased and the number of survivors to the most aggressive episodes, the ones that look for health services, decreased. There also was a decrease in the number of complaints and police report filings.

Preexistent gender inequalities, especially related to discriminatory culture structures, have made the situation even worse to women. Many countries where inequalities between genders and violence against women is already high had increased feminicide and violence cases records during Coronavirus pandemic (Rana, 2020).

In addition, health services access decreased, which impairs early diagnosis and treatment of violence against women. Health systems have been intensely directed to COVID-19 infection prevention, combat and treatment, leading to an almost complete reconfiguration of service strategies to the population (WHO, 2020).

The significant signals for the rise in violence against women cases, the current pandemic scenario, progressive recession and slow world economy recovery, health professional's difficulty to maintain effective assistance to violence against women victims and the small number of papers approaching this theme highlight the importance of works in this area.

This study synthetized literature data concerning how the Coronavirus pandemic (COVID-19) and social isolation process is affecting women, regarding domestic violence.

2. Methodology

This is and Integrative Literature Review. This methodology was chosen to guarantee study synthesis. It has the following stages: theme definition and leading question elaboration; literature search; data extraction; analysis of selected studies; discussion of results; synthesis and presentation of information (Souza et. al., 2017).

Integrative review is an important tool to compare and synthesize current evidence, phenomena, and concepts in many fields of knowledge. In Health Sciences it stimulates evidence-based practice (EBP) and propitiates an optimized assistance, since it can identify common points in a research problem, providing tools for a reflective practice (Souza et al., 2017).

After identifying the theme, the following leading question was made: "How does the Coronavirus pandemic and social isolation process have influenced the increased amount of violence against women cases?". This question was elaborated following PICO (Patient/Population, Intervention, Comparison/Control, Outcome) strategy, rearranged for integrative reviews (Richardson et al., 1995).

A search was done in Pubmed, Excerpta Medica dataBASE (Embase), Cochrane Library, and Virtual Library of Health (VLH), which covers the databases Literatura Latino-americana e do Caribe em Ciências da Saúde (LILACS), Pan American Health Organization (PAHO-ÍRIS), Índice Bibliográfico Español en Ciencias de la Salud (IBECS), World Health Organization (WHO-IRIS), Scientific Electronic Library Online (SCIELO) Preprints, Base Regional de Informes de Avaliação de Tecnologias em Saúde das Américas (BRISA/RedTESA) and Ministerio de Salud del Perú (MINSAPERÚ), and returned results for the search terms.

Health Sciences Controlled Keywords (DeCS) used in all searches were: “mulheres”, “violência doméstica”, “violência de gênero”, “violência contra a mulher” e “infecções por coronavirus”. A highly sensitive strategy was used, adding all terms related (or synonymous) to the main term. In Pubmed and Cochrane Library the terms were translated to the corresponding Medical Subjects Headings (Mesh): “women”, “domestic violence”, “gender-based violence”, “violence against women” and “coronavirus infection”. In Embase the keywords followed Embase subject headings (Emtree). In VLH the keywords were used in Portuguese, English, French and Spanish along with their category codes.

In order to prevent underestimation of results, search terms were arranged in sets: #1 “women”, #2 “domestic violence”, #3 “gender-based violence”, #4 “violence against women”, #5 “coronavirus infection”. The search strategy followed the same steps in all bases, respecting the search language. After sensitive search of each search term, they were grouped with Boolean operators OR and AND: #6 #2 OR #3 OR #4 OR #5; and #7 #1 AND #6 AND #5. The filter “paper fully available”, provided by the database, was applied in the VLH search. Papers from Medline were excluded since they were duplicates from Pubmed. The whole search process was conducted on December 7th, 2020.

Inclusion criteria were: papers related to the search theme, with no restriction on language or publication date. Database search order was: Pubmed, Embase, Cochrane and VLH. Exclusion criteria were: duplicates, not fully available, not related to the theme, literature review, case reports, opinion articles, editorials and comments.

Two hundred fifty articles were identified: 84 in Pubmed, 158 in Embase, 1 in Cochrane and 13 in VHL. Search results were exported to online references organizer EndNote Web and were filtered to eliminate duplicates. 45 articles were excluded in this process. The remaining papers (211) were exported to Rayyan, online facilitator app for reviews. All papers were filtered to identify duplicates once more, and 12 articles were excluded in this process, remaining 199 studies for analysis.

Inclusion process was done by two reviewers, doble-blinded, in three stages. Phase 1: reading title and abstract; Phase 2: resolution of questionable and conflicting cases; Phase 3: reading the full text of all remaining articles.

Studies were selected according to PRISMA strategy (identification, selection, eligibility and inclusion) (Brazil, 2015), as shown in Figure 1.

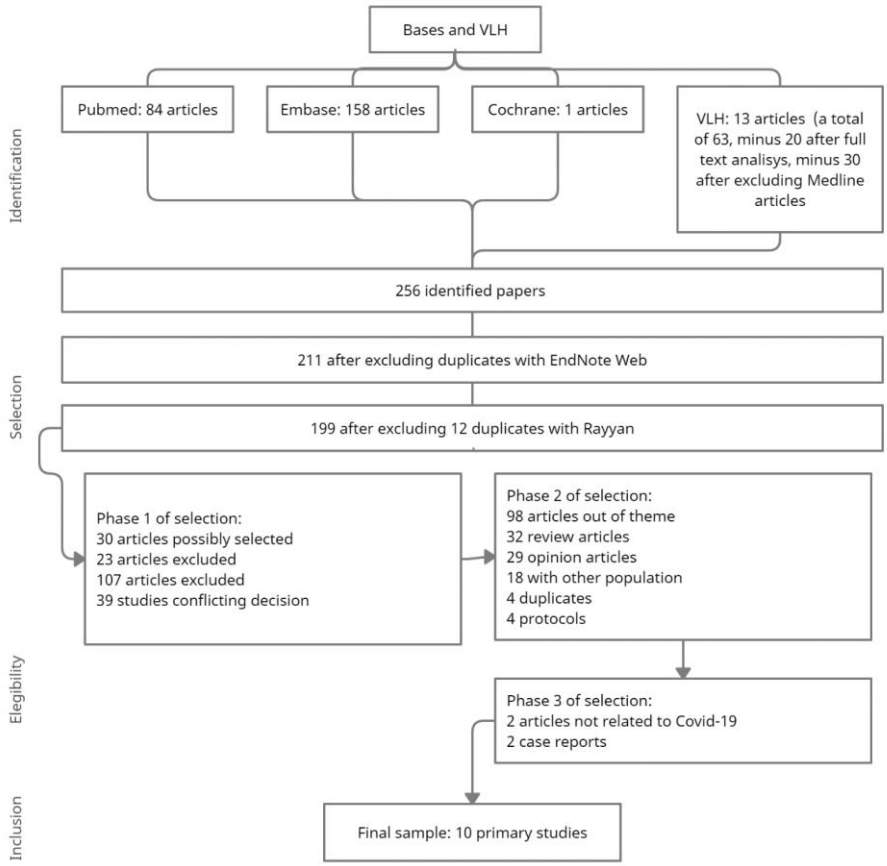

Figure 1. Articles selection flowchart according to PRISMA strategy.
Source: Elaborated by the author, 2021.

Ten primary studies were included in this review. Data collection occurred with a validated categorization instrument (Ursi, 2005). Evidence level was not considered as exclusion criterium, due to the small scientific body of this matter. Analysis was performed in a descriptive manner, by reading and synthesizing each study included in this review.

3. Results and discussion

All ten included articles were published in English. 50% of publications investigated the correlation between "domestic violence" and "Coronavirus pandemic" and the other 50% included the variable "mental health impact". All studies were classified transversal, eight of them had quantitative approach, one qualitative approach and one mixed approach.

The countries included in the studies were: Jordan, United States of America (USA), Ethiopia, Pakistan, Italy, Tunisia, Peru and Netherlands. In five studies (50%), women belonged to the community and in three (30%) they were in vulnerably situation. One study investigated violence in vulnerable families, and one approached communities' men and women. Six studies were conducted remotely (e-mail, electronic forms, phone calls and forms available in social media, such as Facebook, Whatsapp, and local ones), two (20%) checking public data, and two (20%) in presential interviews or in-person self-applied questionnaire. All included studies are synthesized in Table 2.

Table 1. Publication information synthesis of selected articles

IN	Title	Authors	Local the study was conducted and publication year
1	*Violence against Jordanian Women during COVID-19 Outbreak*	S. Abuhammad	Jordan / November 2020
2	*Intimate partner violence against reproductive age women during COVID-19 pandemic in northern Ethiopia 2020: a community-based cross-sectional study*	T. G. Gebremeskel, G. G. Gebremeskel, D. B. Tadesse	Ethiopia / October 2020
3	*The pandemic paradox: domestic violence and happiness of women*	W. Haq, S. H. Rasa, T. Mahmood	Pakistan/ November 2020
4	*Women's mental health: acute impact of COVID-19 pandemic on domestic violence*	S. Sediri, Y. Zgueb, S. Ouanes et. al.	Tunisia/ October 2020
5	*Exacerbation of Physical Intimate Partner Violence during COVID-19 Lockdown*	B. Gonsagi, H. Park, R. Thomas et. al.	USA / August 2020
6	*Time from COVID-19 shutdown, gender-based violence exposure, and mental health outcomes among a state representative sample of California residents*	A. Raj, N. E. Johns, K. M. Barker et. al.	USA / August 2020
7	*Effect of COVID-19 pandemic on women's health and safety: A study*	B. Sabri, M. Hartley, J. Saha et. al.	USA / October 2020

	of immigrant survivors of intimate partner violence		
8	*COVID-19 and the rise of intimate partner violence*	J. M. Aguero	Peru / September 2020
9	*Gender-based violence during the COVID-19 pandemic response in Italy*	R. Ludin, B. Armocida, P. Sdao et. al.	Italy / December 2020
10	*Domestic violence in families in the Netherlands during the coronavirus crisis: A mixed method study*	B. Tierolf, E. Geurts, M. Steketee	Netherlands / October 2020

Source: Elaborated by the author, 2021. IN: Study identification number.

The first study held an online survey with 687 Jordan community women. Its objective was to determine domestic violence prevalence among Jordanian women and to identify possible correlations between domestic violence and Coronavirus pandemic. Most participants were 18 to 25 years old, 35% were married and 40% reported suffering violence during isolation process. Two hundred eighty-seven women were victims of violence, and 70% of them had children with the aggressor, about 40% called the police at the aggression moment; however, in only 10% of the cases the aggressor was arrested (Abuhammad, 2020).

Only 9.8% of the women had suffered physical violence previously to social isolation, indicating an increase in the number of new cases or intensification of cases in which women had not suffered physical injury yet. The most prevalent kind of violence was the physical one, where 68.3% of women reported suffocation aggression and 3.5% by weapons. 45.6% had their mobile phone taken, 20.2% got indirect threats, usually by text messages, 14.6% had their pets assaulted, 16.7% were induced to take medicine and 70.7% were blamed for being assaulted (Abuhammad, 2020).

Prevalence of physical violence in this study contrasts with other studies, where verbal, psychological and property violence were most frequent during the pandemic. One plausible explanation may be that physical violence against women is considered as a legitim discipline method in some cultures, commonly associated to patriarchal communities and restrictive religions (Haq, Raza, Mahmood, 2020).

This reasoning line can be supported by the fact that among women that were assaulted, some were not assaulted only by their partners, but in 19.5% of cases by their brothers, 27.2% by their fathers and 48.9% by their mothers. This last data can also be related to other findings in the same study, that highlight replicated violence, that is, aggression suffered by women was positively correlated to the violence they exerted over their children and family members, especially females (Abuhammad, 2020).

The second study was conducted with Ethiopian childbearing age women, also via online questionnaire, assessing intimate partner violence (IPV) prevalence during the pandemic. It was responded by 682 women, and 24.6% reported as violence victims. The most prevalent violence was psychological (13.3%), followed by physical (8.3%) and sexual (5.3%). Most propense women to be assaulted were housewives, unemployed, under 30 years old and married by matrimonial arrangements. Husband's higher educational level seems to be a domestic violence reduction factor (Gebremeskel, Gebremeskel, Tadesse et al., 2020).

Even though there was an increase in violence prevalence during the pandemic, there were not sufficient comparisons with previous periods to establish a direct relation between increased violence cases and social isolation process (Gebremeskel; Gebremeskel, Tadesse et al., 2020). Younger women propension to domestic violence can be related to other study results, that described lower violence prevalence in women over 40 years old (Haq, Raza, Mahmood, 2020).

The third study was conducted in Pakistan by an online questionnaire with 389 married women. It assessed the relation between COVID-19 lockdown in women empowerment, happiness and violence. Thirty-five percent of them reported suffering violence during isolation period, with notable aggression increase since the beginning of the quarantine; 28% suffered verbal and 34% emotional violence. Violence prevalence was smaller in nuclear families (couple and children) than in families with parents-in-law, grandparents, siblings-in-law and other relatives. Women's domestic overwork during the pandemic was correlated to aggression cases - 55% of women reported taking care of all domestic tasks, and 42% were entirely responsible for childcare (Haq, Raza, Mahmood, 2020).

Unemployed women also had greater chance of suffering violence; however, this correlation was observed only when a bad marriage relationship previously to the pandemic was reported. Women who worked and had a bad marriage relationship previously to the pandemic had even more chances to suffer violence, since they had more challenges in conciliating external job with domestic activities imposed as obligatory by society (Haq, Raza, Mahmood, 2020).

Events that were most related to violence episodes were: request help with domestic chores, ask for help with childcare or education, and maintain a formal job. In this context, Pakistani women with a higher education level had greater chances of suffering violence than women with less instruction, by the attempt of braking male domination and fighting for equal treatment between sexes (Haq, Raza, Mahmood, 2020). These data contrast to studies done in countries where women already have more civil, financial and social autonomy (WHO, 2020).

The fourth study was conducted in Tunisia, with 751 women responding an online questionnaire. It analyzed lockdown effect over their mental health and possible impact in violence against them. Participants were between 18 and 69 years old with average of 37 years old; 69% were married; 65.1% had children and 34.9% had no kids. Comparison of the three-year average prior to the pandemic with the results obtained, violence against women increased from 4.4% to 14.8% in the lockdown period. Among the types of violence, 96% suffered psychological, 41% economic and 10% physical violence. Approximately 78% were assaulted for the first time after the beginning of the pandemic, and 90% of them did not look for help (Seridi, Zgueb, Ouanes et al., 2020). Self-reported depression and anxiety were

considered factors associated to domestic violence occurrence in this and other studies from this review (Haq, Raza, Mahmood, 2020; Seridi, Zgueb, Ouanes et al., 2020).

Most women (73%) that had already suffered violence before the pandemic reported increase in aggression or evolution to physical violence; 38.7% were not able to maintain their jobs in the social isolation period (Seridi, Zgueb, Ouanes et al., 2020). These data support the findings of another study, where women's work overload was a predisposing factor to violence and to stress, anxiety and depression (Raj, Johns, Barker et al., 2020).

Study number five was conducted in a trauma Reference Hospital in the USA, where notified victims of physical aggression are attended. It evaluated incidence, patterns and gravity of violence to victims during the pandemic, in comparison with the previous three years. Sixty-two victims were attended, which was lower than that of previous years: 104 in 2019, 106 in 2018 and 146 in 2017. However, the number of victims by IPV was 1.8 times greater than the previous three years: 42% of victims reported suffering physical abuse in 2020, against 12% in 2017. The number of injuries per victims and its severity also increased. Severe injuries raised from 17% in 2017 to 38% in 2020. Assaults identified as severe were 5 times greater compared with the previous three years, and the incidence of violence with high risk of death doubled (Gosangi, Park, Thomas et al., 2020).

The most prevalent ethnic group attended was white (65%), contrasting with 26% white in the previous three years. This fact can be explained by the greater difficulty that minority women have to access health services during the pandemic. The decrease in the number of patients can indicate diminished opportunity to access health services, whilst the increase in more severe injuries indicate delay in reaching for help (Gosangi, Park, Thomas et al., 2020).

The sixth study was conducted in the USA and it investigated a possible association between the pandemic and anxiety, depression and domestic violence cases. Two thousand eighty-one residents, both male and female, answered an online questionnaire, with 53.5% maintained normal mental health state during social isolation, 26.8% reported depression or anxiety symptoms and 15.5% reported IPV. Women were more susceptible to violence than man (24% against 6.4%) and presented greater anxiety, depression and stress incidence, which enhanced this group's vulnerability to violence and assault. There were no pre and post pandemic comparisons; however, findings show women as more vulnerable to violence as they imposed to greater workload and domestic responsibilities and, therefore, they are more stressed, anxious and depressed, becoming an even more vulnerable population (Raj, Johns, Barker et al., 2020).

The seventh study was also conducted in the USA, with 45 immigrant women, supported by an immigrant in vulnerability community service, and 17 of its service providers. The interviews were qualitative and conducted by online platforms. It investigated the pandemic impact in this group of vulnerable women. All of them reported violence intensification during lockdown. Fear of deportation, social instability, financial difficulties and unemployment were the main causes of violence against women and abusive situation repetition. Living with the aggressor was an aggravating factor present in all recorded cases (Sabri, Hartley, Saha et al., 2020).

The victims reported an increased persecution behavior and financial control, restricted access to supplies, documentation and health services since the aggressor spent more time at home. There was also a frequent report of psychological manipulation: the aggressors said that, by leaving the house to try to

escape tense situations, women would be infected by COVID-19, or threatened to kick out women and force them to expose themselves to the virus on the streets (Sabri, Hartley, Saha et al., 2020).

Service providers argued that sheltering and intervention possibilities were limited by containment, because women do not have access to technologies, and those who do are under constant watch from aggressors. In addition, in total lockdown, home visits could not occur, police assistance is limited and scape possibilities from an aggression situation are drastically diminished. Incidents that are assisted by the police, usually, turn abuse situation worse, since women shelter services, considered non-essential, were closed during the pandemic. This forces women to go back to their home after filing a report or external intervention in an aggression situation (Sabri, Hartley, Saha et al., 2020).

The lack of presential relationship shattered the confidence relation established between victim and care provider. Even when these professionals are able to maintain a virtual conference routine, they feel insecure about women well-being veracity (Sabri, Hartley, Saha et al., 2020).

The eighth study was performed in Peru and determined call incidence to Línea 100 (helpline for domestic violence), to identify possible correlations with coronavirus pandemic. All call logs between 2007 and 2020 were analyzed. Calls to Línea 100 increased, progressively, in all states of the country according to the pandemic progress: 1.02 times greater in April and 2.12 times greater in July in comparison to the same period in previous years. Specifically, in 2020, there was a 48% increase in the number of calls after the beginning of pandemic, with further progressive increases in the isolation months. This increase was not associated to geographical areas where there was already IPV prevalence nor to specific sociodemographic conditions, such as educational level, health plan access, public services access or possession of durable goods (Aguero, 2020).

The nineth study was in Italy and also analyzed the number of calls to the anti-violence public service, from 2016 to 2020 and its objectives were similar to the previous (8th) study. Average number of calls in isolation period months went from 1306 to 2442 in 2020, a 59% increase if comparison to the previous three years. Women with violence history before the pandemic were responsible for less than one third of all calls (Lundin, Armocida, Sdao et al., 2020), which emphasize violence new cases during this period, in consonance with other studies (Raj, Johns, Barker et al., 2020; Abuhammad, 2020; Gosangi, Park, Thomas et al., 2020).

Study number 10 has the most different outcome of all studies included. It was conducted in the Netherlands, with mixed method and around 200 families in quantitative interview and 50 families in qualitative stage. It identified families assisted by health services during Coronavirus pandemic outcome. No significant differences in domestic violence incidence and child abuse before and after the pandemic were observed, even though one half of the families already lived with some kind of severe violence.

Families involved reported greater stress and family tension due to domestic activities overload and economic tension; however, they denied that these factors reflected in the increase of violence suffered or committed. The authors stated that it is possible to correlate diminished possibility to reach for external help with intrafamilial strategies developed to handle conflicting situations (Tierolf, Geurts, Steketee, 2020).

Some social assistants responsible for providing care to these families also were interviewed. Most of them stated they strived to maintain contact with the families, through phone calls and even meeting in

open places. Uncertainty about the reliability of remotely obtained information about family's well-being was present in most statements (Tierolf, Geurts, Steketee, 2020).

Some factors can be associated to the findings in the Netherlands: the country did not go through a total restriction during the pandemic and all professionals reported maintaining some sort of close contact with the families. Furthermore, a methodological bias was observed in the fact that the questionnaire was directed to the whole family, and not specifically to the violence victim. Since it was applied remotely, it is possible that the aggressor concealed the violent situation, forced or coerced the victim to lessened violence occurrence reports. The authors also highlighted divergences between data from the online questionnaire and directed survey, with an increase in violent reports in the second one (Tierolf, Geurts, Steketee, 2020).

Table 2. Objectives, study design, sample synthesis and main results of included studies

IN	Objectives	Study design and population	Main results
1	To determine prevalence of violence among Jordanian women and to identify correlations between violence against women and COVID-19 pandemic.	Quantitative, transversal; 687 adult women selected by convenience using an online questionnaire.	* Intra familiar patterns govern poly-violence dynamics with women and children; * 40% women reported that they suffered violence during the pandemic; * Violence against women predictors during the COVID-19 pandemic were: be unemployed and be married.
2	To determine violence prevalence against women in reproductive age by partners in the North of Ethiopia during COVID-19 pandemic.	Quantitative, transversal; 682 women in reproductive age, random sample.	* Violence prevalence against women by their partners was 24.6%; * Psychological violence was the most prevalent (13.3%), followed by physical (8.3%) and sexual (5.3) violence.
3	To portray women violence, happiness and empowerment dynamic during COVID-19 lockdown.	Quantitative, transversal; 389 Pakistani women, married, selected by convenience using an online questionnaire.	* 47% women do not consider themselves happy. The main reason for that was work overload, pandemic stress, violence by their partners; * Pakistani women considered very empowered before the pandemic has greater odds of suffering violence than less empowered ones.

4	Study lockdown effect over Tunisian women's mental health and its possible impact over violence against women.	Quantitative, transversal, snowball sampling method; 751 Tunisian women used an online survey.	* Violence Against women increased from 4.4% to 14.8% after lockdown started; * 85% women are anxious, stressed or have depressive symptoms, over one half of these had highly severe symptoms. * 73% women that had suffered violence before the pandemic reported increase in violence during lockdown.
5	To evaluate incidence, patterns and severity of injuries in intimate partner violence (IPV) victims during COVID-19 pandemic in 2020, in comparison with the previous three years.	Quantitative, observational, retrospective; patients reporting physical abuse between March 11th and May 3rd, 2020, during COVID-19 pandemic were compared with the same period in the previous three years.	* The total number of patients decreased, but radiographic findings showed violence against women increased 1.8 times in 2020; * The number of abuses identified as stage three was five times greater than the previous three years; * The total number of central injuries was greater (46/12 injuries) in comparison with the previous years (44/27). * Increase in the number of high-risk abuse, including strangulation, weapons and burns victims.
6	To investigate the association between the pandemic with anxiety, depression and domestic violence cases.	Quantitative, transversal; 2081 California residents above 18 years old selected by random sampling.	* 53.5% maintained a normal health state; * 26.8% reported depressive or anxious symptoms; * 15.5% reported violence history from their intimate partner; * 10.1% reported intimate partner violence repeatedly associated to sexual violence; * Intimate violence partner was considered as always associated to predictions of mental disorders; * Women are more liable to violence by intimate partner.

7	To investigate pandemic's impact specifically on intimate violence partner immigrant survivors.	Qualitative, exploratory; interview with 45 immigrants, victims of intimate violence partner and 17 care providers.	* All immigrants reported increase in violence during the pandemic period; * Financial and unemployment difficulties were the greatest amplifier of violence against women; * Increasing domestic workload demand due to isolation measurements was a crucial factor for job loss by women .
8	To determine call incidence to the helpline for domestic violence (*Línea 100*) and to identify correlations between number of calls and COVID-19 pandemic.	Quantitative, transversal; All call logs to *Línea 100* from 2007 to 2020.	* Calls to *Línea 100* increased progressively according to the pandemic progress; * 48% increase in calls since the beginning of pandemic.
9	To determine call incidence to anti violence help service in comparison with the four previous years.	Quantitative, transversal, with systematic analysis; Anti violence help service call logs from 2016 to 2020.	* 59% call increase to anti violence help service in comparison to the same period in the three previous years; * Women with call history to this help services were responsible for less than ⅓ of calls.
10	To understand lockdown impact in families already known by social services.	Mixed method (quanti-qualitative); transversal; 159 families recruited before COVID-19 crises and 97 families recruited during lockdown.	* There were no significant differences between before and during pandemic violence intensity occurrence; * Sense of safety among parents and children was the same before and during pandemic; * Tension and conflict increase were caused by school kids work, chore division at home or care and kids' education.

Source: Elaborated by the author, 2021. IN: Study Identification Number.

Only three of the ten studies selected mentioned potential strategies for the health professionals reach a better outcome in the identification, assistance and solution of violence cases Against women. Among the strategies mentioned was professional training to identify and assist cases of violence against women, especially during pandemic and natural disasters period and war situations (Tierolf, Geurts, Steketee, 2020).

Engagement of emergency services personnel in the identification of suspicious cases, and proper referral of women was also mentioned. This is an interesting approach, since access to less complex support is restricted during isolation, and women tend to look for assistance only in the worst cases (Gosangi, Park, Thomas et al., 2020).

Primary health care professional mobilization and community support were important strategies to assist women that had been in vulnerable situation. Establishing effective communication means with these women, in order to prevent aggravating violence; family, neighbors, friends, social groups and informal support networks, with contact strategies even if remote (one example given was pre-programmed periodic call: in case of no answer for a pre-set number of calls, police and help services are contacted) were positively listed (Sabri, Hartley, Saha et al., 2020).

Training of professionals responsible for monitoring violence cases is an important factor, since if this contact is made in an inadequate manner violence situation can worsen. Strategies, such as questions that have yes and no answers and using words as codes to identify if the call is in speaker, if the victim is alone or if she demands immediate assistance are important (Sabri, Hartley, Saha et al., 2020).

Despite the notorious practical difficulties due to service overload, the role of health systems assuring the rights of women that are victims of violence is extremely important, since it is in this environment that most cases are discovered, notified and treated (OMS, 2020).

Governmental actions were also pointed as extremely important to women rights compliance. Law implementation that punishes more effectively the aggressors and guarantees the victims safety is urgent, since most women chose to not report the violence suffered for fear of the aggressor or by not believing in a favorable outcome by justice (Abuhammad, 2020; Sabri, Hartley, Saha et al., 2020).

4. Conclusions

Regardless of divergencies and cultural peculiarities, violence against women is a global public health problem. Intense social tension situations, such as Coronavirus pandemic, were positively correlated to the expressive increase in gender-based violence occurrence in 90% of the analyzed studies. All these factors lead to the conclusion that women are a propense population to suffer violence during a pandemic period, especially those who did not have a good relationship before isolation.

Stress, anxiety and depression also had positive correlation with violence propension in most studies. Women work overload was also an important factor to mental disfunction occurrences and greater chance of violence. Vulnerable populations are even more exposed during moments of crises, for that reason implementation of public policies that consider these public specificities are extremely important.

Health professionals are placed in a constrained situation before the present scenario faced by women victims of violence. Most of them have reduced physical and technological resources, and little or no specific training to assist victims.

There are few studies conducted about this theme with methodological quality. Research development related to professional strategy implementation and the relation between pandemic and social isolation period and domestic violence increase in specific cultural contexts are important to understand the phenomenon and factors involved, as well as to guide professionals in their practices.

Limited actions and strategies were taken by governments and health agencies to capacitate professionals and reduce the abysm between women rights and what is really available to them in practice. Public policies that recognize and treat this problem specifically and assertively are necessary to guarantee human rights to women. Meanwhile, the "shadow epidemic" – as the increased number of violence cases against women was designated by the WHO (2020) – continues to take catastrophic proportions worldwide.

5. Acknowledgement

The research is financed by the authors.

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Search strategy

Research date: 07/12/2020

Search terms, according to Decs:

mulheres
English: Women
Spanish: Mujeres
French: Femmes

Codes:
M01.975
SP3.001.004.080
SP4.127.413.649

AND (boolean descriptor)

violência doméstica
English: Domestic Violence
Spanish: Violencia Doméstica
French: Violence domestique

Codes:
I01.198.240.856.350
I01.880.735.900.350
SP2.006.052.073

OU (boolean descriptor)

violência de gênero
inglês: Gender-Based Violence
espanhol: Violencia de Género
francês: Violence sexiste

Codes:
I01.198.240.856.463
SP2.036.332.007
SP3.001.005.030.060.040

OU (boolean descriptor)

violência contra a mulher
English: Violence against women
Spanish: Violencia contra la Mujer
Franch: Violence Contre les Femmes

Codes:
SP2.006.052.078.010
SP3.001.005.030.060.040.010

AND (boolean descriptor)

Infecções por Coronavirus

Englis: Coronavirus Infections
Spanish: Infecciones por Coronavirus
French: Infections à coronavirus

Codes:
C01.925.782.600.550.200

PUBMED

-> The terms have been translated into Mesh:

#1 "Women"[Mesh] OR (Girls) OR (Girl) OR (Woman) OR (Women's Groups) OR (Women Groups) OR (Women's Group)

AND

#2 "Domestic Violence"[Mesh] OR (Violence, Domestic) OR (Family Violence) OR (Violence, Family)
OR
#3 "Gender-Based Violence"[Mesh] OR (Gender Based Violence) OR (Violence, Gender-Based) OR (Dowry Death) OR (Death, Dowry) OR (Dowry Deaths)
OR
#4 "Violence"[Mesh] OR (Atrocities) OR (Structural Violence) OR (Violence, Structural) OR (Assaultive Behavior) OR (Behavior, Assaultive)
OR
#5 "Intimate Partner Violence"[Mesh] OR (Partner Violence, Intimate) OR (Violence, Intimate Partner) OR (Intimate Partner Abuse) OR (Abuse, Intimate Partner) OR (Partner Abuse, Intimate) OR (Dating Violence) OR (Violence, Dating)

AND

#6 "Coronavirus Infections"[Mesh] OR (Coronavirus Infection) OR (Infection, Coronavirus) OR (Infections, Coronavirus) OR (Middle East Respiratory Syndrome) OR (MERS (Middle East Respiratory Syndrome))
OR
#7 "COVID-19"[Supplementary Concept] OR (COVID 19) OR (COVID-19 Virus Disease) OR (COVID 19 Virus Disease) OR (COVID-19 Virus Diseases) OR (Disease, COVID-19 Virus) OR (Virus Disease, COVID-19) OR (COVID-19 Virus Infection) OR (COVID 19 Virus Infection) OR (COVID-19 Virus Infections) OR (Infection, COVID-19 Virus) OR (Virus Infection, COVID-19) OR (2019-nCoV Infection) OR (2019 nCoV Infection) OR (2019-nCoV Infections) OR (Infection, 2019-nCoV) OR (Coronavirus

Disease-19) OR (Coronavirus Disease 19) OR (2019 Novel Coronavirus Disease) OR (2019 Novel Coronavirus Infection) OR (2019-nCoV Disease) OR (2019 nCoV Disease) OR (2019-nCoV Diseases) OR (Disease, 2019-nCoV) OR (COVID19) OR (Coronavirus Disease 2019) OR (Disease 2019, Coronavirus) OR (SARS Coronavirus 2 Infection) OR (SARS-CoV-2 Infection) OR (Infection, SARS-CoV-2) OR (SARS-CoV-2 Infections) OR (COVID-19 Pandemic) OR (COVID 19 Pandemic) OR (COVID-19 Pandemics) OR (Pandemic, COVID-19)
OR
#8 "severe acute respiratory syndrome coronavirus 2" [Supplementary Concept] OR (Coronavirus Disease 2019 Virus) OR (2019 Novel Coronavirus) OR (2019 Novel Coronaviruses) OR (Coronavirus, 2019 Novel) OR (Novel Coronavirus, 2019) OR (Wuhan Seafood Market Pneumonia Virus) OR (SARS-CoV-2 Virus) OR (SARS CoV 2 Virus) OR (SARS-CoV-2 Viruses) OR (Virus, SARS-CoV-2) OR (2019-nCoV) OR (COVID-19 Virus) OR (COVID 19 Virus) OR (COVID-19 Viruses) OR (Virus, COVID-19) OR (Wuhan Coronavirus) OR (Coronavirus, Wuhan) OR (SARS Coronavirus 2) OR (Coronavirus 2, SARS) OR (Severe Acute Respiratory Syndrome Coronavirus 2)

Search:

#9 #2 OR #3 OR #4 OR #5

119,922 results

#10 #6 OR #7 OR #8

94,811 results

#11 #1 AND #9 AND #10

TOTAL: 84 results

EMBASE
-> The search terms were translated into the Emtree language:

#1 'female'/exp OR (females) OR (woman) OR (women) OR (women, working)

AND

#2 'domestic violence'/exp
OR
#3 'gender based violence'/exp OR (gender-associated violence) OR (gender-based violence) OR (gender-

related violence)
OR
#4 'violence'/exp OR (dangerous behavior) OR (dangerous behaviour)
OR
#5 'partner violence'/exp OR (intimate partner violence) OR (partner abuse) OR (spouse abuse)

AND

#6 'coronavirus disease 2019'/exp OR (2019-nCoV disease) OR (2019-nCoV infection) OR (COVID 19) OR (COVID 2019) OR (COVID19) OR (nCoV 2019 disease) OR (nCoV 2019 infection) OR (novel coronavirus 2019 disease) OR (novel coronavirus 2019 infection) OR (novel coronavirus disease 2019) OR (novel coronavirus infection 2019) OR (Wuhan coronavirus disease) OR (Wuhan coronavirus infection)

#7 #2 OR #3 OR #4 OR #5

#8 #1 OR #6 OR #7

TOTAL : 158 results

Query('female'/exp OR 'female' OR 'females'/exp OR females OR 'woman'/exp OR woman OR 'women'/exp OR women OR (women, AND working)) AND ('coronavirus disease 2019'/exp OR ('2019 ncov' AND disease) OR ('2019 ncov' AND infection) OR (covid AND 19) OR (covid AND 2019) OR covid19 OR (ncov AND 2019 AND disease) OR (ncov AND 2019 AND infection) OR (novel AND coronavirus AND 2019 AND disease) OR (novel AND coronavirus AND 2019 AND infection) OR (novel AND coronavirus AND disease AND 2019) OR (novel AND coronavirus AND infection AND 2019) OR (wuhan AND coronavirus AND disease) OR (wuhan AND coronavirus AND infection)) AND ('domestic violence'/exp OR 'gender based violence'/exp OR ('gender associated' AND violence) OR ('gender based' AND violence) OR ('gender related' AND violence) OR 'violence'/exp OR (dangerous AND behavior) OR (dangerous AND behaviour) OR 'partner violence'/exp OR (intimate AND partner AND violence) OR (partner AND abuse) OR (spouse AND abuse))

COCHRANE

Search with Mesh terms:

#1 (Women) OR (Girls) OR (Girl) OR (Woman) OR (Women's Groups) OR (Women Groups) OR (Women's Group)

AND

#2 (Domestic Violence) OR (Violence, Domestic) OR (Family Violence) OR (Violence, Family)
OR
#3 (Gender-Based Violence) OR (Gender Based Violence) OR (Violence, Gender-Based) OR (Dowry Death) OR (Death, Dowry) OR (Dowry Deaths)
OR
#4 (Violence) OR (Atrocities) OR (Structural Violence) OR (Violence, Structural) OR (Assaultive Behavior) OR (Behavior, Assaultive)
OR
#5 (Intimate Partner Violence) OR (Partner Violence, Intimate) OR (Violence, Intimate Partner) OR (Intimate Partner Abuse) OR (Abuse, Intimate Partner) OR (Partner Abuse, Intimate) OR (Dating Violence) OR (Violence, Dating)

AND

#6 (Coronavirus Infections) OR (Coronavirus Infection) OR (Infection, Coronavirus) OR (Infections, Coronavirus) OR (Middle East Respiratory Syndrome) OR (MERS (Middle East Respiratory Syndrome))

#7 #2 OR #3 OR #4 OR #5

#8 #1 AND #7 AND #6

TOTAL: 1 result

BVS PORTAL

-> Search with Decs terms

#1 MH:"Mulheres" OR (Mulheres) OR (Women) OR (Mujeres) OR (Femmes) OR MH:M01.975$ OR MH:SP3.001.004.080$ OR MH:SP4.127.413.649$

AND

#2 MH:"Violência Doméstica" OR (Violência Doméstica) OR (Domestic Violence) OR (Violencia Doméstica) OR (Violence domestique) OR MH:I01.198.240.856.350$ OR MH:I01.880.735.900.350$ OR MH:SP2.006.052.073$
OR
#3 MH:"Violência contra a Mulher" OR (Violência contra a Mulher) OR (Violence Against Women) OR (Violencia contra la Mujer) OR (Violence Contre les Femmes) OR MH:SP2.006.052.078.010$ OR

MH:SP3.001.005.030.060.040.010$
OR
#4 MH:"Violência de Gênero" OR (Violência de Gênero) OR (Gender-Based Violence) OR (Violencia de Género) OR (Violence sexiste) OR MH:I01.198.240.856.463$ OR MH:SP2.036.332.007$ OR MH:SP3.001.005.030.060.040$

AND

#5 MH:" Infecções por Coronavirus" OR (Infecções por Coronavirus) OR (Coronavirus Infections) OR (Infecciones por Coronavirus) OR (Infections à coronavirus) OR MH:C01.925.782.600.550.200$

#6 #2 OR #3 OR #4

#7 #1 AND #6 AND #5

(mh:"Mulheres" OR (mulheres) OR (women) OR (mujeres) OR (femmes) OR mh:m01.975* OR mh:sp3.001.004.080* OR mh:sp4.127.413.649*) AND ((mh:"Violência Doméstica" OR (violência doméstica) OR (domestic violence) OR (violencia doméstica) OR (violence domestique) OR mh:i01.198.240.856.350* OR mh:i01.880.735.900.350* OR mh:sp2.006.052.073*) OR (mh:"Violência contra a Mulher" OR (violência contra a mulher) OR (violence against women) OR (violencia contra la mujer) OR (violence contre les femmes) OR mh:sp2.006.052.078.010* OR mh:sp3.001.005.030.060.040.010*) OR (mh:"Violência de Gênero" OR (violência de gênero) OR (gender-based violence) OR (violencia de género) OR (violence sexiste) OR mh:i01.198.240.856.463* OR mh:sp2.036.332.007* OR mh:sp3.001.005.030.060.040*)) AND (mh:" Infecções por Coronavirus" OR (infecções por coronavirus) OR (coronavirus infections) OR (infecciones por coronavirus) OR (infections à coronavirus) OR mh:c01.925.782.600.550.200*) AND (fulltext:("1") AND db:("LILACS" OR "PAHOIRIS" OR "IBECS" OR "WHOLIS" OR "BRISA" OR "MINSAPERU" OR "PREPRINT-SCIELO"))

63 results
43 after full text filter
30 excluded from Medline

TOTAL 13 articles
4 LILACS
4 PAHO-IRIS
2 IBECS
2 WHO IRIS
1 BRISA/RedTESA
1 MINSAPERÚ

1 SciELO Preprints

ENDNOTE

EndNote reference organizer was used. Excluding duplicate files, 211 articles out of 256 remain. (45 duplicates)

Data from 211 EndNote articles were exported to Rayyan
after excluding duplicates, 199 were left (12 duplicates)

RAYYAN

auxiliary search terms

for include:
COVID-19
pandemic
Violence
Women
coronavirus
Domestic Violence
Intimate Partner Violence
Gender-Based Violence
covid 19

for exclude:
literature review
reviews
this review
systematic review
opinion
commentary

-> two reviewers were included, who selected the articles through the system with the "blind ON" tool for activated blind selection.

Reviewer 1, after reading the title and summary:
- incluídos: 51

- excluídos: 146
- maybe: 2

Reviewer 2, after reading the title and summary:
- incluídos: 60
- excluídos: 111
- maybe: 28

ALIGNMENT MEETING:

During the meeting, the blanking tool was deactivated. Reviewers were able to compare selections and discuss the inclusion of articles.
30 studies maybe
23 studies included
107 studies excluded
39 conflicting studies

After the resolution of conflicting and undecided articles, the full text of all articles selected for review was read.
TOTAL AFTER READING COMPLETE TEXT: 10 articles. Both reviewers agreed to the final inclusion of the articles.

Innovation and organizational performance as antecedents of competitive advantage in the context of beef cattle

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Abstract

Agribusiness is a set of linked operations with the objective of producing, benefiting and distributing food. This sector deals with the various activities ranging from genetic improvement to the delivery of the final product. The agents, whether small or large, are inserted in at least some part of the production chain. In this context, it is noteworthy that the innovation that has been defined as a critical issue for cooperation networks. Theory has pointed out that innovation, and organizational performance, has an influence on competitive advantage. In view of this, the general objective of this study was to identify whether innovation and organizational performance are antecedents of competitive advantage in the context of beef cattle, in the view of agents working in cooperation networks in southern Brazil. Therefore, the method proposed for the development of this study is of a qualitative nature, operationalized through in-depth interviews and non-participatory observation. Nine producers were interviewed, from four cooperation networks in the states of Paraná, Santa Catarina and Rio Grande do Sul. The results obtained show that innovation and organizational performance are antecedents of competitive advantage, in the perception of the producers who participated in the study.

Keywords: Innovation; performance; competitive advantage.

1. Introduction

Beef cattle farming occupies a prominent position in Brazilian agribusiness. The country has held the world leadership in beef exports since 2004, and with export projections of 2.55 million tons in 2020 (BEEF MARKET CENTRAL, 2020; USDA, 2020).

World beef consumption has been losing ground, mainly to poultry, over the years. In 1961, beef accounted for 41% of total meat consumption worldwide, and today this percentage is only 22% (FAO, 2019). Developing countries, such as Brazil, have been increasing their beef consumption, mainly due to the increase in their population's income (RITCHIE, 2019), despite the loss of market share for chicken meat.

The expansion of the Brazilian beef cattle herd has more than doubled in the last four decades, but the three states in the southern region of Brazil had growth of only 9.52% (IBGE, 2020). The main reasons evidenced are the opening of new frontiers for cattle breeding in the central-western and northern regions of the country, and the pressure for physical space for grain production (PEDROSO OAIGEN et al., 2013).

In this way, beef producers in the southern states of the country have been experiencing other competitive pressures on their activity, and new models of competition and organization of the production chain have been developed, mainly because they are made up of small producers.

In this competitive landscape, companies need to continuously improve and maintain their competitive position to sustain long-term growth and profitability. Therefore, questions about identifying product competitive advantages become increasingly important (VAN; CAO; J.H., 2017).

In the search for the potential to improve competitive advantages, companies need to focus on the basis of product innovation, quality improvement, and product availability always at the lowest possible costs (HENRIQUES; PEÇAS, 2013).

Innovation is recognized as the mechanism for competitiveness and economic development and as the driving force for creating distinctive value for products, services, and brands (PORTER, 1993; BANBURY; MITCHELL, 1995; GRANDORI; SODA, 1995; NOKAKA et al., 1997; JONASH, 2001; VAN DEN BOSCH; VAN WIJK; VOLBERDA, 2003).

The creation and sustaining of competitive advantage is something that has no "recipe", it is very dynamic, and the establishment of competitive strategies must follow this logic always considering the context (TEECE; PISANO; SHUEN, 1997).

Finally, it can be stated that in companies that seek corporate sustainability and competitiveness in turbulent and complex environments, strategic planning is necessary, but in a different and less formal logic, as argued by (GRANT, 2003).

In this context, the following research question is presented: Are innovation and organizational performance antecedents of competitive advantage in the context of beef cattle raising, in the view of the agents that act in the cooperation networks in southern Brazil?

2. Theoretical Framework and Propositions

2.1 Innovation

The definition of innovation includes the concepts of novelty, commercialization, and/or implementation, i.e., if an idea has not been developed and transformed into a product, process, or service, or has not been

commercialized, it would not be classified as innovation (POPADIUK; CHOO, 2006).

Innovation is an interactive process initiated by the perception of a new market and/or new service opportunity for a technology-based invention that leads to development, production, and marketing tasks that seek the commercial success of the invention (FREEMAN, 1989).

This definition addresses two important distinctions: (i) the innovation process comprises the technological development of an invention combined with the market introduction of that invention to end users through adoption and diffusion, and (i) the innovation process is interactive in nature.

The origin of innovation lies in the shared vision and mission focused on the future, moreover, the vision and mission of an innovative organization is also customer and market oriented, focusing on solving customer problems (COVEY, 1993).

The concept of innovation is not restricted to an idea of improving processes in an organization to facilitate its day to day (DRUCKER, 1986), but in a process that aims to discover, experiment, develop, as well as adopt new products, new production processes and new organizational forms (DOSI, 1988), and can occur in a new product or service, a new administrative structure or system, a new technological production process, a new plan or a program related to the members of the organization (DAMANPOUR, 1991).

In a more evolutionary approach, which goes beyond the logic of transaction costs, the concept of innovation networks is highlighted with more durable and interactive relationships between specific partners in the innovation process, which can also include more informal links between companies and organizations, such as those in industrial districts (ASHEIM, 1996), a given technology or piece of knowledge is not only exchanged, but also collectively developed and the respective knowledge base is increased (TÖDTLING; LEHNER; KAUFMANN, 2009).

Innovation as a collective and interactive process that are distinguished by different mechanisms of innovation and coordination among dispersed actors (MYLAN et al., 2015). Thus, social capital is essential for a company and allows its strategic stance or innovation activities to generate desirable outcomes (ZHOU et al., 2021).

The process of agricultural innovation (knowledge) does not rely solely on the actions and competencies of individual farmers. Agricultural innovation is more influenced by social networks where farmers are embedded or have been purposely created to support and assist them in their innovation efforts by providing relevant information, knowledge, and other resources (ALAIE, 2020).

In open innovation networks, participating actors exchange different resources (technology, managerial and market knowledge, as well as products, services, and personnel) vertically and horizontally across organizational boundaries (ALBERTI; PIZZURNO, 2017).

Research linking interorganizational networks to innovation has emphasized the benefits of knowledge recombination associated with spanning structural gaps and crossing institutional boundaries, as well as in building collaborative ties as a way to engage in knowledge recombination (MARIOTTI; HAIDER, 2020).

Understanding how firms can improve the potential for recombinant innovation and knowledge integration should help firms tune their competencies and capabilities and therefore leverage the contributions of their partners more effectively (FORKMANN; HENNEBERG; MITREGA, 2018).

Collaborating with an increasingly diverse set of partners can produce recombinant innovations, that is, in a new context. FORKMANN; DIEZ-VIAL, 2018; KOBARG; STUMPF-WOLLERSHEIM; WELPE,

2019).

Value creation organization increasingly depends on business networks (MÖLLER; SVAHN, 2003; ANDERSEN; MEDLIN, 2016) and the innovation fostered by these networks (VAN FENEMA; KEERS, 2020).

Innovation in business networks can take many forms, such as business process improvement (DE MARTINO et al., 2013), network relationship development, and collective product-service delivery (TAX; MCCUTCHEON; WILKINSON, 2013).

Interaction is likely to include teaching, learning, coercion, and concession by all participants at specific times and for specific issues, and involves all actors in exchanges between their own counterparts, long- and short-term costs and benefits (FORD; MOUZAS, 2013).

2.2 Performance

Performance is a recurrent subject in most management branches, being a topic of interest for both academics and managers (LIAO; WU, 2009).

The importance of using systems to measure performance is varied, since they can demonstrate how and how well the organization is performing its activities, as well as, the progress it has had over time (LIAO; WU, 2009), as well as, allowing the comparison with the competition (RICHARDS et al., 2009).

Performance effectiveness improves various processes, increases adaptability, creates opportunities, and presents innovation that emerges as a significant source of sustainability (AKRAM et al., 2018).

Organizations try to build sustainable performance through the appropriate combination of organizational capabilities and resources to maintain a balance between operational and economic performance (SZÉKELY; KNIRSCH, 2005).

A well-implemented strategy will create a competitive advantage that will help increase performance (FRIIS; HOLMGREN; ESKILDSEN, 2016; WOGWU; HAMILTON, 2018).

Performance comes from the organization's use of resources, including knowledge, technology, and management resources, which induce the generation of innovations of different types (DAMANPOUR; ARAVIND, 2012). Moreover, the ability of firms to use knowledge more appropriately is a key factor in achieving higher performance (VAN WIJK et al., 2012).

Work done in partnership assists in obtaining and reliably accessing a variety of external resources, capabilities, and information (HSIAN-MING; HSIN-FENG, 2020). And by putting more effort into developing and maintaining inter-firm alliances and networks, a firm can not only gain the advantage of acquiring resources with lower costs and the benefits of economies of scale and scope in manufacturing, but also create the advantages of innovation, research and development, and other activities through the synergy of the partners' corresponding operations and competitive strategies to strengthen its competitive advantage (HSIAN-MING; HSIN-FENG, 2020).

Performance measurement as a means of quantifying the efficiency and effectiveness of activities undertaken by the organization (NEELY; GREGORY; PLATTS, 2005), and organizational learning is a critical part of improving firm performance, emphasizing competitive benefits (HINA et al., 2020)

Firm performance is also enhanced by deploying and developing resources for innovation while complying with the principles of environmental sustainability (LÓPEZ-GAMERO; MOLINA-AZORÍN; CLAVER-

CORTÉS, 2009; CHEN et al., 2015; LEE; CHE-HA; ALWI, 2020).

Organizations have in their power different measurement systems, which can use financial and non-financial indicators, as well as objective or subjective measures (ATALAY; ANAFARTA; SARVAN, 2013). It is observed in the literature studies that address performance in terms of financial performance, operational performance and/or organizational effectiveness, as addressed in the study of (LIAO; WU, 2009). The complexity, adding to other variables that affect organizational productivity performance, such as innovation, leadership, organizational culture (SOEWARNO; TJAHJADI; ANMARISKA, 2020).

2.3 Competitive Advantage

Facing a highly competitive environment, factors such as knowledge assimilation are fundamental to leverage and understand the economic, social and cultural differences of the organizations for success. Other characteristics such as identifying, understanding and enabling for the market also contribute to a successful competitive environment, in addition to observing price and quality (PORTER, 1990).

Organizations that stand out in competitive advantage have evidence of an effective management and a consolidated environment, both technologically and economically, understood as a core of knowledge from which value will be added to products by collective learning (PRAHALAD; HAMEL, 1997), where individuals are essential in the learning process of the organization (HINA et al., 2020).

Partnerships play a significant role in shaping competitive advantage. External resources are incorporated into the cooperation network that provide strategic opportunities and affect behavior and business value (LAVIE, 2006). The studies of (SINGH; MITCHELL, 1996; SAXTON, 1997; STUART; HOANG; HYBELS, 1999; AFUAH, 2000; STUART, 2000; LEE; LEE; PENNINGS, 2001; ROTHAERMEL, 2001) show that partners' resources influence the competitive advantage of the interconnected firm.

The competitive advantage of a network can be understood as a function of the combined value and rarity of all resources and the interactions arising between partners, and is influenced by the interactions, combinations, and complementarities between its internal resources and its partners (AMIT; SCHOEMAKER, 1993). The heterogeneity of these resources requires that not all partners possess the same amount and types of resources (PETERAF, 1993). Networks articulate a set of resources, which are all the types of assets, organizational processes, knowledge, capabilities, and other potential sources of competitive advantage that are owned or controlled by the network, and that can produce a positive, neutral, or negative impact on its competitive advantage. This result depends on the characteristics of each resource: its value and rarity (BARNEY, 1991).

From another point of view, Lavie (2006), states that acting in networks has an important contribution to resource homogeneity, facilitating asset flows between interconnected partners, but that generally, alliances do not increase competitive advantage by contributing to resource heterogeneity. However, under conditions of pure resource homogeneity, alliances will be formed only for collusion purposes, rather than to gain access to complementary resources. Mergers and acquisitions may be even more effective than alliances for these purposes.

The competitive advantage of a company that operates in a cooperative network, based on the combination of internal resources and partner resources, is greater than its competitive advantage if evaluated on the

basis of its internal resources alone. Firm-specific, partner-specific, and relationship-specific factors play a role in determining the type and magnitude of rents extracted from both the firm's internal resources and the resources of the alliance partners (LAVIE, 2006).

Despite growing evidence of the contributions of partnerships in cooperative networks to competitive advantage, most of the studies reviewed do not provide a comprehensive theoretical framework to explain this important relationship between network resources and network performance, nor how networks combine internal and external resources to gain competitive advantage.

Organizations need to leverage their knowledge-based resources to develop a knowledge-based economy, so these firms can enhance their overall performance and gain a sustainable competitive advantage by relying on organizational intellectual assets to deliver enhanced and innovative products and services (AKRAM et al., 2018).

2.4 Propositions

2.4.1 Proposition 1: Innovation positively influences organizational performance.

In its essence, the term innovation captures the novelty of an idea that attempts to improve organizational performance (CAMISÓN-ZORNOZA et al., 2004).

Several studies indicate that innovation positively influences organizational performance (BOWEN; ROSTAMI; STEEL, 2010; CHIANG; HUNG, 2010; CARAYANNIS; GRIGOROUDIS, 2014; POPA; SOTO-ACOSTA; MARTINEZ-CONESA, 2017). Similarly, a study conducted by (JIMÉNEZ-JIMÉNEZ; SANZ-VALLE, 2011) show that product, process, and organizational innovation positively influence organizational performance.

Thus, innovation is essential to improve organizational performance, since organizations that focus on innovation are more successful in securing greater market share, which can lead to high revenues and profitability (GARCÍA-MORALES; LLORÉNS-MONTES; VERDÚ-JOVER, 2008).

2.4.2 Proposition 2: Organizational performance positively influences competitive advantage.

Ho and Ho,Mohd-Raff, (2019) suggest that it is essential to investigate the impact of external and internal factors on firm performance and sustain performance for long-term survival. Nustini, Yuni (2006) concludes that the firm must control its performance to sustain its competitive advantage.

Thus, the indicators of the "competitive advantages" dimension reflect the benefits related to the achievement of value and improvement of organizational competitiveness, with respect to increased productivity and organizational performance (BRYNJOLFSSON; HITT; KIM, 2011; MÜLLER; FAY; VOM BROCKE, 2018).

3. Methodology

The research presented here is qualitative in nature. Several researchers such as Attride-Stirling (2001), Gummesson (2000), Hoskisson et al., (1999), and Van Maanen (1979) have considered qualitative research as one of the main methodologies used when exploring organizational and managerial issues.

The research strategy adopted in this study is based on case studies. The case study "involves the study of

a topic explored through one or more cases within a limited system" (CRESWELL et al., 2007).

The following techniques were used for data collection: semi-structured interview, non-participant observation and consultation providing data triangulation. For the treatment of this information, the NVivo® software was used, i.e., for the codification of all the material collected during the interviews (systematized by means of audios and transcriptions), with the specialists of the beef cattle farming cooperation networks, field diaries of the researcher (containing notes of the observed evidences) and also of secondary data (technical reports of the cases' performance, strategic plans, among other analyzed documents).

The instrument used for data collection was a structured questionnaire with 35 questions, where the researcher asked each interviewee to answer individually. All interviewees belonged to the technical staff or producers associated with the corresponding cooperation network. The choice of interviewees was made by convenience of the researcher. The interviews were recorded with prior consent of the interviewee, and were conducted between January 10 and 27, 2020, and totaled 5 hours and 37 minutes, with an average of 38 minutes per interviewee.

3.1 Characterization of the Cases

The following is a description of the cooperation networks of the three southern states that participated in the research.

3.1.1 Case 1 – GRUPO NOVICARNES – Pato Branco, Paraná

Association located in the city of Pato Branco, in the state of Paraná, created in May 2005, where an association of cattle breeders of precocious cattle started to be called NOVICARNES Cooperative, being constituted by 21 cooperated members. The cooperated cattle farmers, known as Grupo NOVICARNES, started to organize themselves on capital call practices and/or financing support lines creating a structure composed of a cold storage plant, supported by a complete transportation system of animals rescue to the cooperative members' properties and a distribution sector of its products (NEUMANN; BARCELLOS, 2006).

3.1.2 Case 2 - COOPERALIANÇA – Guarapuava, Paraná

The Aliança Mercadológica de Guarapuava is composed and led by producers of early steers in the municipality of Guarapuava (Paraná), who develop marketing agreements with meat packing plants and retail chains in the state of Paraná. Characterized by a horizontal network of relationships, it was formed by the organization of 18 producers, which coordinates the transactions from producer to retail of meat from superprecocious animals (BRAGA, 2010).

Currently, COOPERALIANÇA has more than 140 associated producers and its products can be found in more than 100 points of sale in the state of Paraná, with its own industrial plant in the final stages of construction (COOPERALIANÇA, 2020a).

3.1.3 Case 3 – COOPERTROPAS – Lages, Santa Catarina

In 2013, a group of producers in the Amures region started the Campos das Tropas Integration and Experience Exchange Club, with an indefinite duration. The program's fundamental principles were

cooperation and mutual help, promoting technological development, associativist education and technical professional improvement of the members of Campos das Tropas, through lectures, conferences, meetings, meetings, courses and technical monitoring with the purpose of cattle production of early calves of British breeds and finished on pasture (COOPERTROPAS, 2020).

3.1.4 Case 4 – APROCCIMA – Antônio Prado, Rio Grande do Sul

The Association of Rural Producers of the Campos de Cima da Serra (APROCCIMA) was created on May 26, 2006, but the embryo of the association dates back to October 1997, when the Integration and Exchange of Experience Club 120 (CITE 120) was founded. APROCCIMA was born from another internal demand from the CITE 120 producers, who, in a way, already had a good internal organization of the productive system in general, but the producers felt the need to extend their action outside the gate, and act at the production chain level.

APROCCIMA was created to organize productive chains, integrating agricultural and livestock systems with forestry and tourism resources and value the production of the Campos de Cima da Serra of Rio Grande do Sul and currently has 27 associated producers (APROCCIMA, 2019). The association performs the function of identifying useful knowledge and coordinating with the whole network the generation of knowledge, assimilation and the integration of new knowledge to the existing ones (FILIERI; ALGUEZAUI, 2012).

4. Results

4.1 Proposition 1: Innovation has a positive influence on organizational performance

The strategy of offering a significantly new product, with a differentiated market positioning, in terms of price, quality and relationship with the customer, enabled one of the researched chains to build its own meatpacking industry with its own resources, which is part of the production chain management, by eliminating or mitigating inefficient links that do not contribute to the final value of the product.

The business model developed and the management style adopted by the networks are related to the development of innovations, which in turn positively affect the organizational performance. This can be verified in some of the interviewees' answers.

> "Every time we innovate, like last year when we offered Wagyu (2020) beef crossed with Angus, as a differentiated product, the price is higher. There have been some positive results." (Interviewee A).
>
> "If we don't innovate, if we don't make the changes on top of what the market wants, we will lose competitive advantages. We will be losing to our competitors. That's the fear we can't have, because fear of a competitor is a certificate of incompetence." (Interviewee A).

> "Our business model provides opportunities for small producers to be placed in the market, so we are able to access markets in a much easier way than if we were isolated." (Interviewee B).
>
> "We were able to access restaurants, chefs that we couldn't access before, exactly because of our new products, processes, meat technologies, and differentiated ways of commercialization." (Interviewee

B).

"This whole market, this gourmetization of beef, was largely due to the participation of Cooperaliança in Paraná. Outside the state there are other companies that developed the same work. Today, the barbecue chef has the pleasure of having 4, 5, 6 different cuts and grilling them. Before the habit was more of a skewer, today the grill is gaining more space because the roasts are very fast. Today we roast the forehead, the chuck, which used to be pressure cooker meat. We have a prime rib roast, ancho steak, chorizo steak, short rib roast. It's several cuts, which the co-op has a lot to do with this gourmetization of meat." (Interviewee D).

"We have sought in training, with consumers and with our employees, to offer differentiated cuts, suggestions for dishes, recipes. This is undoubtedly an innovation." (Interviewee A).
"We want to have a larger carcass size, a better standard, and therefore a better price, guaranteeing the market these specifications. The racial standard, fat coverage, are some of these standardizations. We do studies for feed standardization with the objective of standardizing meat flavor, so that the consumer buys meat with a certain flavor this week and with the same flavor the next week." (Interviewee F).

"We price our sales above the commodity price [...] when we sell a product with the price above the market, we establish a different relationship with the customer." (Interviewee D).

"If we did not have this quality standard, we would not be able to add value, [...] we would not be able to remunerate the producer in a satisfactory way. Our product has a higher production cost, and the producer needs to receive more for that, but on the other hand, if we don't have quality we won't be able to remunerate him adequately." (Interviewee E).

"The higher the quality of the product, the higher the added value. So we can sell better and that is a differential that improves our financial performance." (Interviewee I).

4.2 Proposition 2: Organizational performance has an influence on competitive advantage

It was found that superior organizational performance gives cooperation networks some competitive advantages. The first of these is the freedom to charge prices up to 25% higher than competitors. This is possible because of the efficient management of the production chain, the quality of the products and services, and the trusting relationship established with the clients. The other is the management of resources throughout the production chain, which minimizes losses of efficiency and provides conditions for profitability to producers, even when charging prices similar to those of rivals.

"Today the cooperative has an average remuneration around 20 to 25% higher than the common market, which is what all the slaughterhouses in the state pay, a remuneration like that you imagine that for every 5 steers that you sell in the common market, you would only need 4 inside the

> cooperative, because it is 20% a significant difference and this money goes to the producer's hand." (Interviewee H).

In this way, this capacity to take responsibility for the organization of the production chain gives the researched networks a sustainable competitive advantage, given the complexity of the productive arrangement, its cultural dynamics, the capacity to appropriate knowledge resources, the scarcity of some strategic resources, as well as the difficulty of being replicated in a short period of time.

It is still possible to see that the organizational performance, by the answers of the interviewees, when asked if the work of the network is carried out in collaboration.

> "Yes, there is a popular saying: 'the more sickle, the bigger the field. We don't know everything, and being this way, we need to surround ourselves with people who know what we don't know. In some subjects we are always ignorant, in the literal sense of the word. It is mandatory that no matter how much knowledge you have, you have to look for people who complement what you don't know how to do." Interviewee A, (2020).

> "Our producers in the vast majority have higher education in the most different areas, bringing with them their experiences [....] everyone doing their best for the group's result. So these differentiated experiences, they bring this sum." Interviewee A, (2020).

> "[...] for our producers to be producing quality, they need to have a head, a different culture, they are producers more adept at adopting knowledge and technology, most of our producers are not cattle farmers by essence, they are farmers who already have a cooperative culture of their agricultural production system, most, I believe 98% of our producers are farmers and are associated with some other cooperative." Interviewee E, (2020).

> "We have partnerships with some of our suppliers, who work a lot in the search for information, we do some field work, and from these works that new information is generated, which is passed on to the cooperated producers." Interviewee D, (2020).

> "The financial performance comes by consequence, but the competitive advantage itself is made within the serious work we perform [...] committing to the producer, helping him to produce efficiently and have profitability when processing the product, remunerating according to our carcass classification table." Interviewee E, (2020).

In this way, it is possible to infer the existence of a common thread between financial performance and competitive advantage, which gives the cooperation networks studied a differentiated competitive condition.

> "The competitive advantage that the producer has is the higher price and the scale of slaughter." Interviewee E, (2020).

> "We know about the price oscillations, but we managed to stay almost three years with the same price

for the producer, around 12% above any slaughterhouse." Interviewee F, (2020).

5. Final Considerations

The complex dynamics of competition and constant change have made it virtually impossible to use off-the-shelf solutions to current and future problems. Given this realization, organizations need to create value to gain competitive advantage, and the best way to do this is through innovation. While this obvious realization is not recent, a systemic view of innovation in relation to the non-economic aspects of innovation, such as the social and cultural aspects, provides a better understanding of the notion of innovation.

It is known that efficient production chains better manage resources in all their stages, as well as provide customers with new experiences and added value. It is still preponderant in Brazil the aspect that agribusiness is a supplier of raw material, since the times of Cabral to foreign countries and/or now to the industrial sector, and not as an important participant in the process of transformation and aggregation of value.

Some networks have adopted an open innovation model to make their projects feasible, looking for partners that can contribute to the efficiency of the beef production chain.

The disorganization of this chain, the dissatisfaction of the producers with the industry, the availability of resources from educational, research, and extension institutions, the awareness that the guarantor of the quality of the final product is the rural producer, and that there was no conflict of interest between the producer links and the final consumer, were some of the situations raised as motivators for the consolidation of a chain organization model from the producer's perspective.

Organizational performance motivates networks to launch new innovative products and services to sustain market advantages among competitors. Many factors have been shown to support organizational performance growth and competitive advantage, and one of them is organizational culture, which can be seen during the interviews conducted.

It is recommended for future studies to quantify the relationships between the constructs in a wider sample, which was not possible in this research, not only because of those who were not willing to participate in the study, but also because the size of the total population of the identified arrangements that operate in cooperation networks in the southern region of the country does not support a study of this nature.

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Language teacher professional education: The role of peer-to-peer learning in online environments

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Abstract

This article provides a theoretical discussion regarding the implications of peer-to-peer learning in online environments for language teacher professional learning and second language academic literacy. It approaches the use of technology as means to enhance prospective teachers' cognition and metacognition skills and to foster their language learning, as Language Teacher Education programs usually fulfil a twofold purpose: to learn the language itself and to learn how to teach it as a foreign language. In order to arrive at these implications, it presents a grounded discussion on sociocultural perspective within L2 teacher education, teachers' beliefs, and mediation in the sociocultural perspective. The discussion reinforces the significance of peer-activities (peer-observation and peer-feedback) to foster a teacher development process. Moreover, it suggests that a guided peer-activity, such as employing the use of carefully elaborated rubrics, could enhance this process.

Keywords: Language teacher education, Peer-to-peer learning, Peer-feedback, Online peer-review

1. Introduction

Teacher Education is a process where we have to understand ourselves to be able to modify concepts and to become aware of what surrounds us to provide better guidance to students, i.e., "the teacher cannot help the student to overcome his or her ignorance if the teacher himself or herself cannot permanently overcome his or hers" (Freire, 1996, p. 95, our translation). And reflecting on self-behavior and especially reflecting with the support of a peer is an essential activity to achieve awareness. To exemplify, Hendry et

al. (2021) report that their study with teachers conducting peer-observation demonstrates that this activity enhances their practice. Moreover, Comoglu and Dikilitas (2020) highlight the role of verbally recorded reflections on developing mutual motivation, deepening ideas, and providing mutual support in Peer Practicum.

However, on another research with teachers having to write their reflections using an online-shared journal, Elhussain and Khojah (2020) concluded that the data show little evidence of this enhancement. The authors report that teachers' writings were more descriptive than reflective. Perhaps guiding the activity with thoroughly designed rubrics could assist in reaching the aimed reflectiveness, as demonstrated in a research conducted by Muck (2015) employing rubrics. Employing Muck (2015, p. 18)'s words, the "opportunity for reflection and their [participants'] perception of the importance of informal knowledge may have been fostered by the rubrics". According to the author, rubrics also allowed participants to organize and articulate their thoughts, to examine events in an organized way, recollect thoughts, identify issues and challenges, select information, and rethink the structure of knowledge. "These cognitive processes promoted a metacognitive process: participants became aware of what they know and reflected on how they developed the knowledge of what they know" (Muck, 2015, p. 18).

Therefore, peer-to-peer activities, such as peer-feedback, guided by attentive rubrics could be an activity to promote expert mediation in Teacher Education programs. After all, as Johnson and Golombek (2020, p. 124) state, "[c]reating opportunities for teachers to reflect on and re-conceptualize how they might enact their teaching practices in varied instructional contexts will no doubt be part of the life-long professional development of all L2 teachers".

On the other hand, it is undeniable that these activities involving peers are very time demanding on several levels, such as on the elaboration, development, and evaluation of the activity. This scenario has been changing with the affordances of new technologies that are enabling changes in education. One example of such technology that automatizes the entire peer-feedback process and evaluation is the multimodal online resource called CGScholar (Muck, 2015, 2016; Muck & Sadki, 2015).

In this line of thought, bearing in mind the significance of peer-activities (peer-observation and peer-feedback) to foster a teacher development process, and acknowledging that a guided peer-activity, such as employing the use of carefully elaborated rubrics, could enhance this process, this essay intends to shine some light on the subject of mediation in online Teacher Education programs. It discusses some implications of peer-to-peer learning in online environments for teacher professional learning and second language academic literacy, such as the use of technology as means to enhance prospective teachers' cognition and metacognition skills and to foster their language learning, as these programs usually fulfil a twofold purpose: to learn the language itself and to learn how to teach it as a foreign language.

This essay is organized in the following fashion, and it contains excerpts of chapters from one of the authors' doctoral dissertation. Firstly, it presents a grounded discussion on the following aspects, in that order: 1) Sociocultural perspective within L2 teacher education, 2) Teachers' beliefs, and 3) Mediation in the sociocultural perspective. In the sequence, it provides some implications of peer-to-peer learning in online environments for teacher professional learning and second language academic literacy. Finally, it presents some final considerations.

2. Sociocultural perspective within L2 teacher education

The point of view through which researchers have seen teacher learning, according to Johnson (2009), has shifted from a positivist epistemological perspective to an interpretative perspective. The main difference between them is in how they place teachers (either in-service or in pre-service) and knowledge in society. The positivist epistemological perspective perceives teachers as isolated objects of scientific investigation, studying their psychological self and not taking into account their relationship with society. Knowledge, in this view, is external to the individual and can be captured in isolation. The interpretative epistemological perspective, on the other hand, observes what teachers do and how and why they do it. This perspective sees the teacher as part of society and, consequently, knowledge as something that is socially built.

It is possible to state that perspectives on language teacher education have shifted from one extreme to the other. There is the positivist epistemological perspective, which is based on knowledge- transmission, on the one hand, and the interpretive epistemological perspective, which is socially situated, on the other hand. The former defines "learning as an internal psychological process isolated in the mind of the learner and largely free from the social and physical contexts within which it occurs" (Lenneberg, 1967, in Johnson, 2009, p. 7). In this line of reasoning, learning is considered as an individual and isolated process in which context, culture and social interactions are irrelevant.

In this perspective, Johnson (2009, p. 8) states that knowledge about teaching and learning can be transmitted, for instance, through lectures and books, and can be transported to other settings as something static. She states that knowledge "is considered to be objective and identifiable and represents generalizable truths. In other words, knowledge is out there and can be captured through the use of scientific methods" (Johnson, 2009, p. 7). These scientific methods, as stated by the author, encompass replicable methods that take into account issues of validity and reliability as well as a random selection of participants to be representative of a population. Based on that, results are generalizable, and this knowledge (the result of research) is transported to other contexts. Considering this epistemological view of knowledge, Freeman and Johnson (1998, p. 399) claim that

> teacher education programs generally operated under the assumption that teachers needed discrete amounts of knowledge, usually in the form of general theories and methods that were assumed to be applicable to any teaching context. Learning to teach was viewed as learning about teaching in context (the teacher education program), observing and practicing teaching in another (the practicum), and, eventually, developing effective teaching behaviors in yet a third context (usually in the first years of teaching). (Freeman & Johnson, 1998, p. 399)

In the 1970s, as Johnson (2009) states, in reaction to this epistemological perspective, realizing that classrooms are complex settings embedded with context and culture, researchers realized that it was insufficient to know what teachers do. There was a need to have access and to disclose why teachers do what they do. The central question for researchers became, in Johnson (2009, p. 9) words, "How do teachers

participate in and constitute their professional world?".

These investigations of teacher cognition lead to a reconceptualization of the knowledge-base of L2 teacher education moving the epistemological perspective from knowledge-transmission to cultural and socially-situated. What should, then, language teachers know in order to teach a language? The knowledgebase in L2 teacher education, according to Johnson (2009, p. 11),

> informs three broad areas: (1) the content of L2 teacher education programs: *What L2 teachers need to know*; (2) the pedagogies that are taught in L2 teacher education programs: *How L2 teachers should teach*; and (3) the institutional forms of delivery through which both the content and the pedagogies are learned: *How L2 teachers learn to teach*. (Johnson, 2009, p. 11)

The focus of this article is to discuss how to develop and implement effective pedagogy in online settings of teacher education, especially in the two last-mentioned areas, which demand mediation. In the sociocultural perspective, learning to teach, in Johnson's words, "is based on the assumption that knowing, thinking, and understanding come from participating in the social practices of learning and teaching in specific classroom and school situations" (Johnson, 2009, p. 13). From this perspective, context, culture and social interactions are essential.

For that reason, the sociocultural perspective embraces several issues inherent to L2 teacher education, namely: 1) it provides explanations for teacher learning cognitive processes; 2) it understands teacher education as a continuum process of reformulation and reconstruction; 3) it provides both "the content and the processes of L2 teacher education" (p. 13) interrelating everyday knowledge to scientific knowledge; and 4) it involves teacher educators in utilizing mediational tools integral to the context (Johnson, 2009). These concerns will be briefly addressed in this order.

As listed in the previous paragraph, drawing on Johnson (2009), the first of the issues inherent to L2 teacher education, in a socio-cultural viewpoint, is that it provides explanations for the cognitive processes taking place in teacher learning. The sociocultural perspective "provides us with a theory of mind that recognizes the inherent interconnectedness of the cognitive and the social" (Johnson, 2009, p. 13). According to the author, it allows the understanding of teachers' reasoning and transformation, and the effect of this process on themselves, on the students, and on the activities they engage in.

A second issue is that a sociocultural perspective understands teacher education as a continuum of processes of reformulation and reconstruction. Johnson (2009, p. 13) asserts that "a sociocultural perspective on L2 teacher education involves changing, and not simply reproducing, L2 teachers and their instructional activities". According to this line of thought, the author states that this perspective recognizes teacher education as a process through which reformulation takes place in order to meet "both individual and local needs" (*idem*). Information and communications technologies (ICTs) can be helpful in this process. Alonso (2008), when discussing the relation between ICTs and teacher education in the Brazilian context, states that it is expected that the ICTs would "catalyze transformations in the modes of teaching and learning, in the way of being a professor" (Alonso, 2008, p. 748).

A third issue is the fact that a sociocultural perspective provides the content and the processes of L2 teacher education (Johnson, 2009, p. 13), as well as interconnecting everyday knowledge to scientific

knowledge. According to Johnson (2009), students arrive at L2 teacher education programs with their assumptions concerning language and language learning and teaching. These assumptions come from the experiences they have faced in their lives as students and as teachers. This knowledge, in the sociocultural perspective, is regarded as everyday knowledge. The other type of knowledge, the scientific – which is produced in a theoretical realm – offers prospective teachers the opportunity to go beyond their everyday concepts. It is an opportunity to reevaluate, reformulate, and resignify beliefs as well as to change behaviors. It is important to state that these two types of knowledge have a dialogic relationship. The relevance of this rests on the fact that it "positions teachers not as passive recipients of theory but as active users and producers of theory on their own right, for their own means, and as appropriate for their own instructional contexts" (Cochran-Smith & Lytle, 1993, in Johnson, 2009, p. 15).

The last concern is that a sociocultural perspective involves teacher educators in utilizing mediational tools and creating new tools to promote opportunities for teachers to externalize their everyday concepts – their beliefs. Once these concepts on a certain issue are externalized, through mediation, scientific concepts are introduced. Beliefs, then, are reconceptualized. Moreover, this reconceptualization is a process that results in a different outcome for each individual due to his or her everyday concepts and the specific social and cultural context s/he is inserted in (Johnson, 2009).

In sum, while the positivist epistemological perspective to language teacher education is based on knowledge-transmission, the sociocultural perspective is a cultural and socially situated perspective. The former understands teachers as passive receivers and deliverers of a package of static knowledge that is already complete and can be delivered in and applied to different contexts. The latter, on the other hand, comprehends teachers as life-long activists in their own process of learning and teaching as knowledge is socially co-constructed and mediated.

3. Teachers' beliefs

Eisenhart et al. (1988) conducted a review of literature on teacher beliefs from the early 1960s to the mid-1980s. They went to the cognitive anthropology field to build their working definition of teacher beliefs, which is the definition adopted by the present investigation. They state that "to accept a proposition as true is to value it in some way for logical, empirical, social, or emotional reasons. That is, a belief is a way to describe a relationship between a task, an action, an event, or another person and an attitude of a person toward it" (Eisenhart et al., 1988, p. 53).

Teachers' beliefs are personal judgments regarding the process of teaching and learning, derived from their experiences as learners (of languages and other subjects), as learners of teaching, and as teachers. These personal judgments are characterized as knowledge developed in and with our social activities. In sociocultural theory, this knowledge is called *spontaneous concept* (Vygotsky, 1986) or *everyday concept* (Johnson, 2009). In addition to this knowledge is the *scientific concept* (Johnson, 2009; Vygotsky, 1986) which embraces the knowledge that is produced on theoretical grounds. The challenge of teacher education, according to Johnson (2009), is to introduce scientific concepts in a way that they can connect to everyday concepts establishing a dialectic relationship.

These concepts are all constructed in specific contexts. Human cognition, as Golombek and Doran

(2014, p. 104) state, "is conceptualized as originating in and being shaped by engagement in social activities, emerging on the inter-psychological plane and gradually transforming to the intra-psychological plane". Cognition, in Kalantzis and Cope (2012, p. 211)'s words, "happens as much outside of the brain as it does inside. It finds fertile ground in the open potentialities of the brain, and so shapes the brain. The transformative task of education is to support this learning process". Context, therefore, in line with sociocultural theory, shapes teachers' conceptualization of teaching inasmuch as these experiences (as learners and teachers) happen in specific cultural and socially grounded spaces. In other words, teachers' social interactions in their cultural environment performing it. It is a process from the external interactions to an internal personal mediation.

From a sociocultural perspective, this process of transformation from inter to intra-psychological planes is called internalization (Golombek & Doran, 2014, in Johnson, 2009). It is when "a person's activity is initially mediated by other people or cultural artifacts but later comes to be controlled by him/herself as he or she appropriates and reconstructs resources to regulate his or her own activities" (Johnson, 2009, p. 18). Golombek and Doran (2014) argue that the mind is mediated as "humans understand and act on the world by means of psychological tools that are appropriated in the context of specific goal- oriented sociocultural activities" (Golombek & Doran, 2014, p. 104). This mediation, according to Johnson (2009, p. 18) occurs through three types of tools: 1) cultural artifacts and activities, which, as an example, can be the "textbooks and the instructional activities they engender" (Johnson, 2009, p. 18); 2) concepts, such as the idea of teaching as the act of simply delivering knowledge; and 3) social relations, as the "differential power relations between teachers and students" (Johnson, 2009, p. 18).

A sociocultural perspective on education perceives teaching, learning, and development as interrelated (Johnson, 2009). In this line of thought, instead of being teacher-centered or student-centered, education is centered on the activities and resources that students and teachers engage in together with the purpose of leading student's cognitive development.

This cognitive development is achieved through instruction. According to the author's definition of instruction through a sociocultural lens, cognitive development is the ultimate goal and one that is reached through a cyclical process of dialogic mediation. Students need to be aware of the everyday concepts they are dealing with so that the scientific concepts can be introduced and, through meaningful activities, they would be able to re-conceptualize those concepts and solve problems by themselves (Johnson, 2009, p. 63). Instruction, in this sense, as Johnson points out, "can be characterized as a dialogic mediation process of reconceptualizing and recontextualizing knowledge" (*idem* p. 62). It is precisely the dialogic mediation process of reconceptualizing and recontextualizing knowledge that relates concept development to teachers' beliefs. This conceptual thinking, according to Vygotsky (1998, in Johnson, 2009, p. 64) is "a new form of intellectual activity".

Moreover, Johnson (2009) argues for the notion of a dialectic relationship between the everyday concepts and the scientific concepts. One is built and/or developed upon the other. To illustrate this mediation process I will provide the three examples she offers to (i) demonstrate the reconceptualization of concepts of methodology, language, and teaching; (ii) the reconceptualization of reading comprehension instruction; and (iii) the scaffolded learning and assisted performance.

In order to illustrate the reconceptualization of concepts of methodology, language, and teaching,

Johnson describes, for example, the activities she engaged in with her Master's students when she observed their everyday concepts on methodology, in which they believed in the idea that there is the best method of teaching; on language, which they conceived, for example as being a static entity; and on teaching, which they comprehended as the act of delivering content. Johnson then introduced scientific concepts and, through activities involving verbalization, she promoted dialogic mediation.

In the last two instances, the author illustrates the reconceptualization of reading comprehension instruction and scaffolded learning, and assisted performance. The former describes how a teacher engages in a dialogic relation with the researcher: the teacher verbalizing her thinking and the researcher influencing it. The latter provides extracts of classroom interaction – examples of how the quality of both teachers' questioning patterns and their mediation of classroom interaction can lead to cognitive development.

4. Mediation in the sociocultural perspective

According to Kohl (1997), Vygotsky studied the higher mental processes, which are those that are more complex, such as imagining something we are not seeing or thinking in a future event. These higher mental processes are different from the elementary mechanisms, which are reflexive actions, automatized actions and simple associative process between events. A central conception to understand the psychological functioning of these higher mental processes is the concept of mediation. Vygotsky (1981) states that human beings can have a direct relation to the world, or they can have a mediated relation to it. In his words,

> [i]f we turn our attention to types of social connection, we discover that even relations among people are of two types. It is possible to have direct and mediated relations among people. Direct relations are those based on instinctive forms of expressive movement and action. […] At a higher level of development, however, mediated relations among people emerge. The essential feature of these relations is the sign, which aids in establishing this social interaction (Vygotsky, 1981, pp. 159-160).

This mediation can be through instruments or signs. Drawing on Kohl (1997), the instruments are objects that exist between someone and his/her objective. For example, when one wants to turn on the television employing a remote control, the remote control is the instrument. As for signs, they are psychological instruments. The author states, they work as symbolic instruments. They are the representation of objects, situations or events. Moreover, they are collectively built inside society by interaction; their meaning is shared in society.

Mediation, however, is a broad term in Vygotsky's thinking, according to Wertsch (2007). The author outlined Vygotsky's mediation in two general types: explicit mediation and implicit mediation. He summarizes the differences between them in the following:

> Explicit mediation involves the intentional introduction of signs into an ongoing flow of activity. In this case, the sign tends to be designed and introduced by an

> external agent, such as a tutor, who can help reorganize an activity in some way. In contrast, implicit mediation typically involves signs in the form of natural language that have evolved in the service of communication and are then harnessed in other forms of activity. (Wertsch, 2007, p. 185)

In Lantolf and Thorne (2006, p. 63)'s view, everything is mediated. For them, the difference is that in some cases the mediation is external (that can be seen) and in other cases the mediation is internal (it happens in our minds).

In any case, external/internal or implicit/explicit, mediation is what leads someone from A to B, being A and B everything: a thought, a place, an object, an action, and so on. Sometimes we can accomplish the task of achieving B by ourselves employing just our mind as mediator. Other times, however, we need guidance from someone or something with more knowledge to go from A to B. To exemplify the two situations, imagine that a group of students receives the task of writing a play. Some of them may have knowledge of the literary elements that comprise the genre drama (context, dialogue, plot, characters, symbolism); they will perform the task employing this knowledge. Other students, on the other hand, might be completely unaware of the requirements of the genre drama, and other students may know that the genre requires separate dialogues for each character, but they are still unable to grasp the complexity of the task. Therefore, they need guiding help to write the play. Some possible help sources could be the following: their peers who know what the literary elements are; the teacher who assigned the task; books and/or online texts on the subject; and so on.

Vygotsky (1978) calls *actual developmental level* the stage where students accomplish moving from A to B by themselves, and *potential developmental level* the stage where students need more expert guidance to arrive at B. From the example above, it is already possible to visualize that each student may have a different level of knowledge about the elements of drama at the moment they received the task. This means that the students who are at the potential developmental level will need more or less guidance on the subject to accomplish the task. The theorist named this amount of needed guidance the *zone of proximal development* (ZPD), which is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 33). Still employing the example, each student then would be in a different ZPD.

5. The implications of peer-to-peer learning in online environments for teacher professional learning and second language academic literacy

The concepts presented in the preceding sections provide the essential elements to understand the role of knowledge reconceptualization in teacher education and the function of mediation in this process. This is particularly relevant because mediation is a core resource on online peer-review processes, which can foster prospective teachers' metacognition. Inasmuch as knowledge is mediated and co-constructed during peer-review, knowledge is being reconceptualized and recontextualized. In this sense, it demonstrates that it is created and recreated in sociocultural relations, which are subverted with peer-review

activities, as they require self-regulation.

> Self-regulation creates a learner and assessment centered focus where the teacher becomes a facilitator as opposed to an expert, and learners assume a more active role. This can foster shared purpose and responsibilities among learners and the teacher in ongoing monitoring, assessment and provision of feedback to their peers. These are critical requirements particularly in online learning environments where learners are expected to assume primary responsibility for their learning. (Gikandi, Morrow & Davis, 2011, p. 2346)

However, "these enactments which are core to online pedagogy will essentially depend on teachers' beliefs" (Gikandi, Morrow & Davis, 2011, p. 2347). Therefore, online peer-review activities in teacher education programs are activities by which prospective teachers can start perceiving their beliefs and acting upon them and, consequently, changing pedagogical decisions. Therefore, this section postulates a philosophical justification for collaborative learning technologies and provides pedagogical implications for teacher professional learning. To start with, it is relevant to have a broad understanding of the context.

Since 2006, the Brazilian Open University (UAB[1]) has offered a variety of undergraduate and graduate degree programs via agreements with other universities with the goal of promoting the following[2]: 1) universal access to college; 2) strengthening of the countryside schools; 3) deconcentration of courses from major centers, thus preventing migration to big cities; 4) teacher education; and 5) (re)qualification of human resources. Given these objectives, the Brazilian Federal Government has increased funding and public policies aiming at expanding online distance education in the country (UAB, 2016).

Regarding the goals of UAB listed above, our interest lies in teacher education, as a considerable number of teachers in Brazilian public schools do not hold an undergraduate degree or act in areas other than those for which they have been educated. To exemplify, in Brazil, in 2000, 47.3% of the teachers teaching primary or secondary school[3] held an undergraduate degree (Scheibe, 2006). The Brazilian Government, through the CAPES[4] Foundation, has been developing a program for primary and secondary school teacher education[5] since 2009. It seems that this effort has already impacted education as this percentage increased to 79%[6], in 2013. Despite this visible improvement, there is still a long path to be travelled, as we still have to embrace the professional development of 21% of teachers that are already in-service, based on data from 2013. Moreover, we also have to devote special importance to the education of teachers to be and address the quality of these in-service and pre-service programs.

In this scenario, online language teaching undergraduate programs have occupied a privileged position in the Brazilian's Government as they are meant to fulfill this gap of lack of professionalization,

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[1] It is the acronym for Brazilian Open University in Portuguese: *Universidade Aberta do Brasil*. I will employ the acronym UAB because it is already widely used in Brazil.

[2] http://www.uab.capes.gov.br/index.php?option=com_content&view=article&id=9&Itemid=21. Access in February 20, 2013.

[3] Primary + Middle School is the equivalent to *Ensino Fundamental* in Brazilian's educational system.

[4] CAPES, in Portuguese, is the acronym for *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (Coordination for the Improvement of Higher Education Personnel).

[5] "Plano Nacional de Formação de Professores da Educação Básica-PARFOR. http://www.capes.gov.br/educacao-basica/parfor

[6] Source: http://portal.inep.gov.br/indicadores-educacionais

especially in regions far from industrial centers and state capitals. Concerning specifically English language teaching, in the first semester of 2013, there were 25 undergraduate programs in teaching English offered in Brazil, according to a search conducted on the website of the Ministry of Education and Culture – MEC (MEC, 2013). Thirteen of these programs form teachers to teach English and Portuguese, i.e., teachers get a degree to teach both languages. The other 12 undergraduate programs focus on the education of English teachers, with a total of six of these being public. It is relevant to highlight that the Brazilian foreign language teaching programs have two objectives: to teach students (prospective teachers) a foreign language and to teach them how to teach this foreign language. The implementation of UAB in a country with the territorial proportions of Brazil is a challenge and, certainly, a work in progress and with continuous change and adaptations to diverse contexts.

In this line of thought, it is undeniable that to increase the number of teachers with a teaching degree is an urgent task. However, after fifteen years of the implementation of the Brazilian Open University (UAB) program, it is equally relevant to test new systems of improving students' experiences on online foreign language teacher education programs in order to provide opportunities to develop meta-cognition during real social interaction activities such as peer-reviewing. The advances of technology have made this task not only possible but also enabled a task design that diminishes the burden on facilitators and empowers students.

These public programs have been run through a blended system of education, having most of the interaction conducted online and employing the Modular Object-Oriented Dynamic Learning Environment (Moodle) as Learning Management System (LMS). This online interaction is centered on an e-tutor system, where each e-tutor is responsible for providing assistance and feedback to a certain group of students. This system highlights the practice of having the e-tutor as the holder of knowledge and, therefore, being the person that transmits the knowledge to the students. However, if we conceive knowledge to be co-constructed within society, this one-way process of knowledge flow requires revision. With the affordances of the new educational technologies that allow an extensive connection among participants in online educational environments, it is possible to apply a pedagogical approach in which, for instance, formative assessment and recursive feedback, from different sources such as peer-review, can be introduced.

The system of having e-tutors evaluating the students' productions prevents the students from having the same experience of reading and providing feedback for several peers and, consequently, precluding them from all the benefits that this activity could afford. Moreover, students received feedback only from one source: the e-tutor. Understandably, conducting a peer-review activity with several files, for example, of lesson plans (and several versions) would be even more demanding, if the activity had to be manually managed and organized. Kern et al. (2002) and Kern et al. (2003) already pointed out this amount of work as a serious limitation for peer-review activity. According to Kern et al. (2002, p. unnumbered page), some of the functional requirements of a software interface for peer review application in learning are the following: website configuration, CFP [call for papers] and review form publication, student data input, paper submission, referee allocation support, authorship omission, acknowledgment of reception, and author notification. Fortunately, the advances in technology have already provided us with all these requirements, as demonstrated by Muck and Sadki (2015) and Muck (2015).

These new technological affordances enable us to change paradigms in education both in online and

in face-to-face settings and, therefore, "pedagogical practices and social structures are transformed" (Dabbasgh, 2005, p. 32). Besides the benefits of peer-to-peer learning, modifying students' social role in the educational process seems to be the ultimate goal of this activity in education. As social identities and social relationships are constructed (Fairclough, 1992), it is time to rebuild the social identity of professors, tutors, and students and develop new relationships among them. In this new educational paradigm professors and tutors renounce their institutionalized current position of knowledge holders and transmitters and become mediators of interactions and guiding students to sources or pathways to obtain knowledge. This innovative relation with knowledge demands an innovative approach to the online teaching-learning social practice.

This educational shift also changes the students' social role. This role demands action and responsibility from students towards their own process of learning and they are embedded with agency to also be autonomous knowledge mediators. Students become responsible for their construction and consumption of knowledge. "Autonomy is an important premise of adult learning. Nevertheless, this premise is at times contradicted in adult learning processes by resistance to change" (Kern et al., 2007, p. 60). And confronting beliefs and facing resistance to change are central aspects of pre-service teacher education as teachers' practices follow their beliefs.

Consequently, the peer-reviewing activity *per se* already challenges this setting because it transfers the learning accountability to the teachers to be, disrupting the common belief that the professor is the only beholder of knowledge. Moreover, by engaging in online peer- review activity, for example on lesson plans, prospective teachers would benefit from reading and providing feedback to other peers and receiving feedback from different peers. Thus, they would be exposed to other beliefs by considering other ways of developing activities and applying theories in a foreign language classroom, and they would be challenged by reviewers when they provide feedback questioning some developments in the lesson plan or provide comments that make students (prospective teachers) question themselves. "Students usually recognize that they can benefit from studying the work of colleagues and reflecting about their own work. This seems to be a strong contribution of peer review: to make students exercise high- level cognitive skills" (Kern et al., 2007, p. 54).

This is the dialectic relationship between the *spontaneous concept* (Vygotsky, 1986) or *everyday concept* (Johnson, 2009) and the *scientific concept* (Johnson, 2009; Vygotsky, 1986) that allows the possible reconceptualization and recontextualization of knowledge. Cope and Kalantzis (2013)'s seven openings for educational transformation (ubiquitous learning, active knowledge production, multimodal knowledge representation, recursive feedback, collaborative intelligence, and differentiated learning) are instruments in online peer-review activities that can enhance prospective teachers' cognition and metacognition, as they promote real, multiple, and contextualized social interactions. The development of metacognition is an important outcome in teacher education.

Another implication of peer-to-peer learning in online environments for teacher professional learning and second language academic literacy regards the learning of language itself. As foreign language teacher education programs in Brazil teach both the language itself and ways of teaching the language, peer review activity exposes students to different uses of the language besides receiving feedback on his or her own work, such as profiting from reading their peers' works, as demonstrated in this research. Additionally,

according to Topping (1998, p. 261), "peer assessment of writing has been used in English-as-a-second language (ESL) contexts in several countries, especially in composition classes". Reviewers, rubrics and the reviewed texts act as mediation tools to foster learning. They act on the *potential developmental level* (Vygotsky, 1978) helping the prospective teachers to move from point A to point B in their writing and to use the foreign language, as well as to understand and apply concepts.

6. Final Considerations

This essay has provided a grounded discussion on sociocultural perspective within L2 teacher education, teachers' beliefs, and mediation in the sociocultural perspective in order to arrive at some implications of peer-to-peer learning in online environments for language teacher professional learning and second language academic literacy. It highlights the importance of peer-activities (peer-observation and peer-feedback) to foster a teacher development process. Furthermore, it recommends guided peer-activities, such as employing the use of carefully elaborated rubrics, to enhance this process.

Finally, it encourages the use of the affordances of technology to enhance prospective teachers' cognition and metacognition skills and to foster their language learning. This is particularly relevant in e-education due to teachers' incessant need for reconceptualization, as we "cannot learn how to get smart if we do not first understand what makes us stupid and how we can reverse it" (Gee, 2013, p. 8). And the first step to act on this stupidity is to face our beliefs. The shift from teacher-centered education to ubiquitous education demands that teachers become knowledge mediators as opposed to knowledge holders in e-education.

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THE APPLICATION OF DATA MINING BY CLASSIFICATION IN A DATABASE OF NOTIFIED COVID-19 CASES IN MANAUS-AM

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Abstract

This scientific article aims to present information on the cases of comorbidity that most aggravate the symptoms of SARS-CoV-2 (Covid 19) with data extracted from the database of the official website of the Ministry of Health, which defined a system to monitor the information detected in the diagnoses of each patient. Since the beginning of the pandemic, the city of Manaus has suffered great consequences in relation to the SARS-CoV-2 virus (Covid-19). predicting patients at higher risk of death. We describe the origin and spread of the virus and the use of the SGBD software MySql and MySql Workbench to improve data in the selection and pre-processing, with the resources of the weka tool for knowledge learning, ending with the objective achieved in the classification of comorbidities that further aggravate the clinical conditions.

Keywords: COVID-19; MySql; KDD; Weka; Workbench; Data Mining.

1. INTRODUCTION

Every day, society produces tons of virtual data through the most different means and forms, like a mountain of information, which, if not interpreted, only serves to occupy space in technological devices. Due to this huge amount of information it is challenging to extract knowledge from this data and the traditional techniques to analyze it end up becoming impractical.

The process of discovering hidden connections and predicting future trends dates back to the 1990s and encompasses the areas of statistics, artificial intelligence and machine learning, thus triggering the emergence of the data mining area.

The use of data mining can bring several benefits to companies and organizations, making good use of information, understanding its relevance, evaluating possible results and accelerating decision making. Data mining seeks to discover relationships and has applications in several areas, such as: assessing the reputation of companies through social networks; bank credit approval; discover market trends or classify a new species of plant or animal.

The interest in the development of artificial intelligence applications for the health area and the potential of such techniques in the prevention of pandemics has been growing in recent years. The pandemic for the new coronavirus (SARS-CoV-2), presents itself as one of the greatest challenges ever faced by modern society, which requires quick decision-making to face this international public health emergency.

The Ministry of Health of Brazil, through the Health Surveillance Secretariat, has been monitoring the Severe Acute Respiratory Syndrome (SRAG) in Brazil, since the Influenza A (H1N1) pandemic in 2009. Since then, this surveillance has been implemented in network of Influenza and other respiratory viruses, which first acted only with sentinel surveillance of Influenza Syndrome (SG).

In 2020, the surveillance of COVID-19 (Coronavirus Disease) was incorporated into this network. COVID-19 is the human infection caused by the new coronavirus, which is a family of viruses, where some infect humans. Another coronavirus had already caused an epidemic in 2002 in China, causing Severe Acute Respiratory Syndrome (known by the acronym in English Sars).

On March 11, 2020, Covid-19 was characterized by the World Health Organization (WHO) as a pandemic. In Brazil, the first case of Covid-19 was confirmed on February 26. Amazonas confirmed the first case of the disease on March 13, 2020.

Until February 8, 2021, the country registered 9,550,301 cases and 232,248 deaths. In the State of Amazonas, according to the State Health Surveillance Foundation, through data from the COVID-19 Daily Case Bulletin of February 8, 2021, it registered 691,241 reported cases, 283,658 confirmed cases and 9,116 deaths.

DATASUS is the IT department of the Unified Health System (SUS) and aims to provide the legacy of the epidemiological databases of SARS, the Influenza and other respiratory viruses surveillance network, from the beginning of its implementation in 2009 until today, with the incorporation of COVID-19 surveillance. Its objective is to collect, process and disseminate health information in the country, in addition to assisting in the support of information technology and systems necessary for the planning, operation and control of SUS agencies. The official system for the registration of cases and deaths of SARS is the Influenza Epidemiological Surveillance Information System (SIVEP-Gripe).

People with comorbidities are considered to be at risk for the disease caused by the Coronavirus, as are elderly people, smokers and those who are considered immunodepressed, such as those who are undergoing cancer treatment with chemotherapy or who have undergone bone marrow transplantation. When treated correctly, diseases considered comorbid to Coronavirus have their risks reduced, as is the case of former cancer patients without evidence of cancer or people with HIV with undetectable viral load.

Due to the large volume of data produced during the pandemic, among them the data from the SIVEP-Gripe system, a manual and traditional analysis would become unfeasible, thus, the main motivation of the present work lies in the fact of the efficiency of the use of mining of data in these large volumes of data generated by the pandemic in Brazil, more specifically in the city of Manaus, in the period from 01/01/2021 to 02/02/2021, and the application of the classification task for knowledge extraction. To achieve this motivation, a more appropriate algorithm to perform data mining will be selected, the reliability of the generated model will be analyzed, provide subsidies to determine the efficiency of the applicability of the generated model.

1. THEORETICAL FRAMEWORK

Before the application of the basic tools of this article is executed, it is important to conceptualize and understand the main subjects that support the proposed theme, of which they will be: Knowledge Discovery in Databases - KDD (Knowledge Discovery); Data Mining Method and its tasks, as well as the Naive Bayes algorithm, the Confusion Matrix and the Weka Tool, which is one of the most simple and widely used data mining tools in academia.

2.1 Knowledge Discovery in Databases - KDD (Knowledge Discovery)

The KDD according to Fayyad et al (2006) is a non-simple way to extract information from a large amount of data stored and to be analyzed. Previously unknown, but potentially useful.

The traditional method of transforming data into knowledge depends on the interpretation and manual analysis of one or more analysts, serving as an interface between data and users. When data volumes grow too large, this type of analysis becomes impractical, slow, expensive and very subjective.

These data, in most cases, are in binary format, are typically bulky and difficult to understand. Thus, KDD aims to transform this data, which can be in the form of: short reports, a descriptive model of the process that generated the data, or a predictive model to estimate future cases.

KDD refers to the entire discovery process, while Data Mining or Data Mining refers to a step in the process that consists of applying data analysis using algorithms that respect the limitations of computational capacity thus producing patterns (CAMILO and SILVA, 2009).

The KDD process consists of a sequence of steps as shown in figure 1 and that must be performed sequentially, because at the end of each step, the result obtained serves as an aid to the next step, being able to repeat previous steps whenever necessary and that will be discussed below.

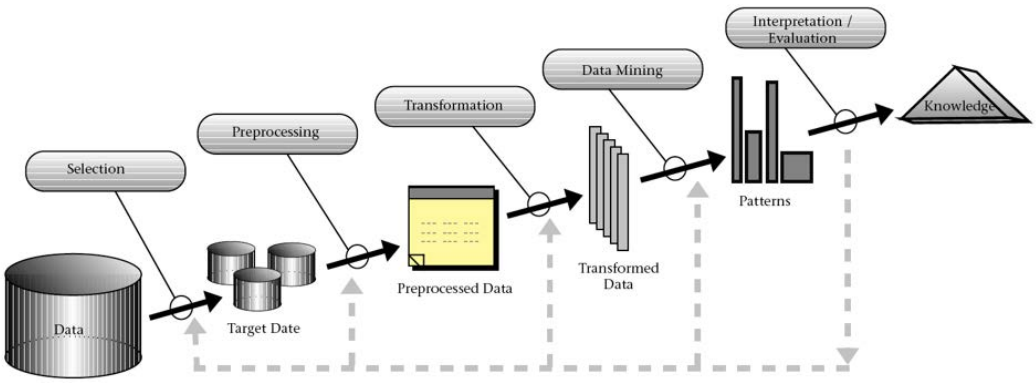

Figure 1: The KDD steps

Source: danielteofilo.wordpress.com/2015/02/16/kdd-knowlegde-discovery-in-database /

2.1.1 Data

The data is all untreated and unprocessed records in which it has a large volume containing all characteristics or attributes. Data are codes that constitute the raw material of the information, that is, it is the untreated information that still has no relevance. They represent one or more meanings of a system that alone cannot transmit a message or represent some knowledge (SILVA, 2007).

2.1.2 Selection

It is a set of data or sample of data with which the discovery process will be carried out. For Zanardi (2007), in this phase, a set of data is selected or a subset of attributes or data instances is focused on, in which the discovery must be made.

2.1.3 Pre-Processing

These data may go through a pre-processing stage where problems such as noise and incomplete data will be dealt with. Data Cleanup methods can be Value Correction, Measurement Error and Data Collection, Noise, External, Inconsistent Values and Duplicate Data.

In the pre-processing phase, data cleaning is performed using operations such as noise elimination and incorrect or incomplete data is neglected. Zanardi (2007) says that it collects the necessary information for modeling and correcting noise and for strategies for manipulating lost data fields.

2.1.4. Transformation

In the data transformation phase, projection and reduction operations may be used, reducing the number of variables under consideration or finding representations of the data that do not vary.

Mendes (2011), says that data transformation consists of converting data to a format interpretable by Data Mining tools, associated with Data Integration, which can come from multiple sources, meet the specific needs of Data Mining.

2.1.5. Data Mining

Data mining is one of the phases of KDD, a step where they are applied to mining techniques, often repetitively, which look for patterns and rules hidden in the data according to the desired objective.

As the main step in the KDD process, Data Mining consists of the application of specific algorithms on the data, in order to abstract knowledge. According to Nangiyalil (2007), these algorithms use inductive learning techniques on databases and are able to extract knowledge through examples, applying interactive methods repeatedly.

Santos (2009, p. 1) defines data mining as the name given to a set of techniques and procedures that tries to extract information of a higher semantic level from raw data, in other words, allowing the analysis of large volumes of data. data for knowledge extraction. (GALVÃO and MARIN, 2009).

2.1.6. Assessment

Phase that interprets the mined and evaluated standards, often in the form of graphs or reports, selecting the useful knowledge of this entire process. (OLIVEIRA; CARVALHO, (2008) FREITAS; LAVINGTON, (1998). It may be necessary to go back to some previous step in an iterative process.

2.2 Data Mining Method

The methods are existing technologies, regardless of the data mining context, since, applied in KDD, they produce good results in the health area, transforming data into useful knowledge.

In addition to the models, Data Mining can be characterized by the choice and application of the algorithms to be applied. Among the main existing methods, we will work with the Classification Rules.

There are several methods that can be used in Data Mining, and their application depends on the type of input data and the type of information desired as an output. The methods are divided between verification and discovery methods. Among those of discovery, they are divided between methods of prediction and description. Predictive tasks seek to forecast a target attribute value. The descriptors try to find patterns, correlations, trends, groups, anomalies.

According to Fayyad et al (1996), the objectives of prediction and description can be achieved using specific data mining methods that are classified according to the models: Predictive and Descriptive. However, for this research only the Predictive format will be used, namely:

- Predictive: Able to predict future or unknown values through some variables. That is, anticipating future behavior or value. Methods that generally use this model are those of Classification, Regression and Detection of deviations.

2.2.1 Classification

The predictive function aims to map a data item from several predefined items. It is one of the most common tasks of data mining and seeks to identify which class a particular record belongs to (SILVA, 2014). In this task, the model analyzes the set of records provided, with each record already containing the indication to which class it belongs, in order to "learn" how to classify a new record (supervised learning). Mendes (2011) explains that this approach allows the construction of classification models, that is, being able to recognize the function that describes a certain class to which an item belongs, from a set of input data.

The classification task consists of a set of records or objects, in which each record is represented by two types of attributes (x, y), in which X represents a set of attributes, of the discrete or continuous type; and Y represents a special attribute of the discrete type, usually referred to as a class.

Thus, Mendes (2011) teaches that each of the classifying methods uses an algorithm called the Learning Algorithm that aims to build models with good generalization capacity and / or that accurately predict the labels of previously unknown record classes. These algorithms work with the following elements:

- Training set: A set of records with labels of known classes is provided;
- Classification model: It is built to relate the set of attributes to the class labels.
- Test set: These are records with labels of unknown classes.

The performance of the classification model is evaluated after the application of the selected algorithm. This assessment is based on counting the test records provided by the model, checking which ones are correct or not. Thus, the performance of the algorithm is calculated by the metric of precision and error rate. It is worth mentioning that most classification algorithms seek models that, when applied to the set of tests, have greater precision or the lowest error rate. (MENDES, 2011)

2.2.2 Naive Bayes Algorithm

Silva (2014) defines the Naive Bayes algorithm as a method that uses conditional probability based on Thomas Bayes' theorem. Camilo and Silva (2009) say that according to Bayes' theorem, it is possible to find the probability that a certain event will occur, given the probability of another event that has already occurred: Probability (B given A) = Probability (A and B) / Probability (A).

This method is easy to build, does not require any complicated iterative parameters and estimation schemes. It can be easily applied to large data sets, easy to interpret, generally performs the classification task well and is robust enough. For the application of the Naive Bayes algorithm, the data must pass through the pre-processing transformation stage where they will be discretized.

2.2.3 Confusion Matrix

In the Classification task, a matrix of predicted results is used in comparison with the original classes observed, known as a confusion matrix.

This matrix seeks to understand the relationship between successes and errors that the model presents and presents itself as follows in Figure 2.

		Valor Predito	
		Sim	**Não**
Real	**Sim**	Verdadeiro Positivo (TP)	Falso Negativo (FN)
	Não	Falso Positivo (FP)	Verdadeiro Negativo (TN)

Figure 2: The confusion matrix

Source: diegonogare.net/2020/04/performance-de-machine-learning-matriz-de-confusao /

The results can be summarized in four initial values, being:

- True Positive (TP): class originally predicted and observed is part of the positive class. (*True Positive* – TP) originally predicted and observed class is part of the positive class.

- ● False Positive (FP): predicted class returned positive but the original observed was negative;
- ● True Negative - TN: the predicted and observed values are part of the negative category;
- ● False Negative (False Negative - FN): it represents that the predicted value resulted in the negative class but the original observed was of the positive class.

2.2 Weka Tool (Waikato Environment for Knowledge Analysis).

Weka, according to Witten, Frank and Hall (2011), is free software developed in Java, widely used for academic data mining, its strong point is the classification task, but it can work with the association rules and data clusters .

Weka can access data from the database through the JDBC connector and its own data files with the extension ARFF (Attribute-Relation File Format). It was developed to be a collection of Machine Learning algorithms, where many of them incorporate concepts of artificial intelligence.

2.3 MYSQL

MySql is a relational DBMS (Database Manager System), which uses SQL (Structured Query Language, or translating, Structured Query Language). MySQL is also multiuser and multitasking. (WELLING, THOMSON, 2003).

2.4.1 *Workbench*

Workbench is a unified visual tool for database architects, developers and DBAs. MySQL Workbench provides data modeling, SQL development and comprehensive administration tools for server configuration, user administration, backup and more. MySQL Workbench is available on Windows, Linux and Mac OS X. (SURHONE, TIMPLEDON, MARSEKEN, 2010).

2. MATERIALS AND METHODS

The methodology applied in this research can be defended as a case study, Ellram (1996) also adds the possibility of using case studies to analyze past events in similar cases and make predictions.

The collection of data on the subject to be presented, regardless of the techniques used, through statistical sources. It also refers to applied, descriptive and qualitative research using an inductive method. (BARDIN, 2009; GERHARDT and SILVEIRA, 2009).

There were also consultations with studies that have already elaborated works on the subject of data mining, KDD, mining algorithms, SGBD MySQL and the Weka Tool. Thus, the research path involved the practical application of the Data Classification technique, which is one of the phases of the KDD process, to allow the generation of a data model from the application of the Naive Bayes algorithm to extract data patterns .

In order to carry out this analysis, it was necessary to capture data from the system made available by the Ministry of Health's website, DataSus, which provides information that serves to support objective analyzes of the health situation, evidence-based decision making and the elaboration of health action programs..

Therefore, initially, these data were exported to the MySQL database management system, to carry out the treatment and pre-processing of the data. Then, these were treated and analyzed in the data mining tool Weka, where the classification algorithms were applied to extract a test model. For this, the Naive Bayes algorithm was used, generating models for tests and the confusion matrix for comparing the results.

Checking the spreadsheet and studying the basis, an attempt was made to analyze whether the sex, age and the comorbidities recorded are related to the severity of the patient's clinical evolution, which may be death or cure. Among the listed data are the sociodemographic, related to sex, age and other indicators related to the individual and the epidemiological ones, which include clinical and laboratory information, such as

results of diagnostic tests, hospitalizations and symptoms of diseases.

The KDD phases carried out in practice will be addressed below:

3.1 Dados

The base where the work was carried out was taken from the official records of the Ministry of Health website, DATASUS, in which the file INFLUD21-08-02-2021 was extracted in .csv format, which refers to the data registered in the SRAG system 2021 - Severe Acute Respiratory Syndrome Database.

This program manages the rates of hospitalizations and diagnoses of patients seen, with 98,975 records, containing data from COVID-19 from all over Brazil in the period from January 1, 2021 to February 8, 2021 (39 days). This short period of time is justified by the large volume of data in the system, the low computational processing power and the intention of the work being only to demonstrate the applicability of the concepts.

The INFLUD21-08-02-2021 file contains data from notification records from all over Brazil, with various information recorded in the COVID-19 case notification. Among these data are sociodemographic data, related to sex, age and other indicators related to the individual; and epidemiological ones, which include clinical and laboratory information, such as diagnostic test results, hospitalizations and disease symptoms.

3.2 Selection

Using the MySQL Workbench tools in conjunction with MySQL DBMS, the records contained in the CSV file were imported into a database called SIVEP and the data was added to the CADASTRO nomenclature table, containing the total record extracted from the site that was on total of 98975 records. The selection phase is the learning of the application domain, where the data to be analyzed and grouped with which it was intended to work were selected, as shown in the figure 3.

```
SELECT sexo,idade,fator_risco,cardiopata,hematologia,sindrome_down,hepatica,asma,diabetes,
       neurologica,pneumotia,imunodepressao,renal,obesidade,outras,evolucao
FROM dados;
```

Figure 3: Sql Selection Script

Source: The Author.

3.3 Pre-Processing and Data Transformation

In this phase, data cleaning and basic noise removal operations took place. In this case, there was a need to generate a new table called DATA and in this table there was the pre-processing of the necessary records to be used in the next phase. The values of the fields were defined as 1-Yes, 2-No and 9-Ignored for the comorbidity fields, and the name of the fields was changed for a better understanding of the data. Some fields had blank values. Blank fields with the value 'N' were processed

The objective of this phase was the search for useful attributes in the data, taking into account the defined objectives and the use of transformation methods in order to reduce the effective number of variables under consideration.

In the selection and pre-processing phases, a script was created to create a new DATA table, with the

converted records, eliminating noise, as shown in figure 4 below.

```
CREATE TABLE dados AS SELECT DT_NOTIFIC as data_notificacao,
CS_SEXO as sexo,
NU_IDADE_N as idade,
FATOR_RISC as fator_risco,
CASE
   WHEN (CARDIOPATI = 1) THEN 'S'
   WHEN (CARDIOPATI = 2) THEN 'N'
   ELSE 'N'
END as cardiopata,
CASE
   WHEN (HEMATOLOGI = 1) THEN 'S'
   WHEN (HEMATOLOGI = 2) THEN 'N'
   ELSE 'N'
END as hematologia,
CASE
   WHEN (SIND_DOWN = 1) THEN 'S'
   WHEN (SIND_DOWN = 2) THEN 'N'
   ELSE 'N'
END as sindrome_down,
CASE
   WHEN (HEPATICA = 1) THEN 'S'
   WHEN (HEPATICA = 2) THEN 'N'
   ELSE 'N'
END as hepatica,
CASE
   WHEN (ASMA = 1) THEN 'S'
   WHEN (ASMA = 2) THEN 'N'
   ELSE 'N'
END as asma,
CASE
   WHEN (DIABETES = 1) THEN 'S'
   WHEN (DIABETES = 2) THEN 'N'
   ELSE 'N'
END as diabetes,
CASE
   WHEN (NEUROLOGIC = 1) THEN 'S'
   WHEN (NEUROLOGIC = 2) THEN 'N'
   ELSE 'N'
END as neurologica,
CASE
   WHEN (PNEUMOPATI = 1) THEN 'S'
   WHEN (PNEUMOPATI = 2) THEN 'N'
   ELSE 'N'
END as pneumotia,
CASE
   WHEN (IMUNODEPRE = 1) THEN 'S'
   WHEN (IMUNODEPRE = 2) THEN 'N'
   ELSE 'N'
```

Figure 4: Pre-Processing and Transformation Script

Source: The Author

The transformation phase is necessary to present the values that are recognized by the tool. In this case, we used the WEKA tool, which has 4 ways to load data to work. The Open DB option was selected, which corresponds to opening a database connection and performing the select operation of the fields in the studied table as shown in the sql script in figure 3.

When entering this script code, the screen as shown in figure 5 is shown, where the graph corresponds to the Procedure table, in which the blue color refers to the HEALING frequency in the table, and the red color refers to the DEATH value in relation to the table..

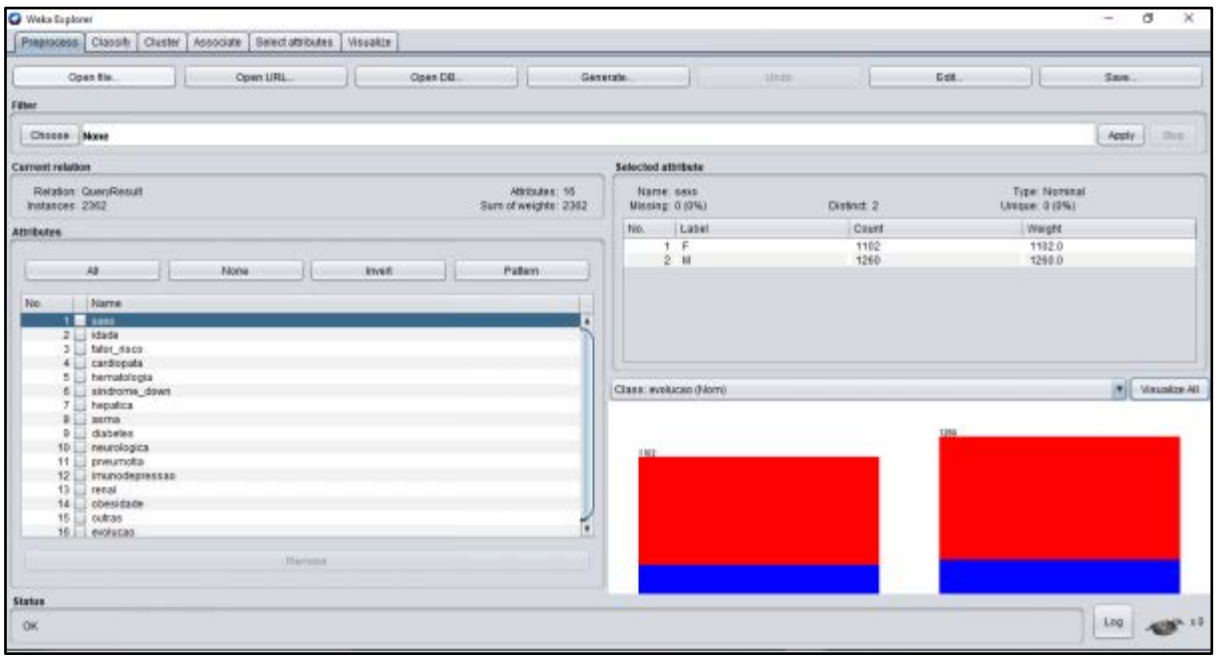

Figure 5: Pre-Processing and Transformation Script

Source: The Author

3.4 Data Mining

The task chosen for data mining of the selected base was that of classification, presented in sequence using the Naive Bayes algorithm. The validation method used in the execution of the algorithms was Cross-validation of k parts. As mentioned by Tan et al (2009), this approach segments the data into k equal partitions, where during each execution one of these partitions is chosen for testing, while the others are used for training. This procedure is repeated k times, so that each partition is used for testing exactly once. The total error is found by adding the error of all k executions. (MENDES, 2011).

3. RESULTS AND DISCUSSIONS

After applying the Classification method to the database with the Naive Bayes algorithm, the Weka tool provided a sequence of data with the results obtained.

2362 instances from the 16 attributes selected in the KDD selection phase were analyzed using cross-validation for model creation and data testing with the model

```
Time taken to build model: 0.01 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances        1925               81.4987 %
Incorrectly Classified Instances       437               18.5013 %
Kappa statistic                          0.3144
Mean absolute error                      0.2717
Root mean squared error                  0.3749
Relative absolute error                 80.4376 %
Root relative squared error             91.2439 %
Total Number of Instances             2362

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0,293    0,042    0,656      0,293    0,405      0,350    0,730     0,524     CURA
                 0,958    0,707    0,832      0,958    0,890      0,350    0,730     0,885     OBITO
Weighted Avg.    0,815    0,564    0,794      0,815    0,786      0,350    0,730     0,807

=== Confusion Matrix ===

   a    b   <-- classified as
 149  359 |    a = CURA
  78 1776 |    b = OBITO
```

EFICIENCIA DO MODELO

MATRIZ DE CONFUSÃO

Figure 6: Results after applying the algorithm

Source: The Author

Figure 6 shows that the efficiency of the model was 81%, correctly classifying 1925 instances and 437 incorrect classifications. The Confusion Matrix presented the results of the classifications, detailing where the number of instances were considered correct and incorrect according to the class considered,

which was the evolution attribute.

- True Positive: 149Falso Positivo : 78.
- True negative: 1776.
- ● False Negative: 359.

It was observed that the cases that most express the values of risk of death in relation to comorbidities are: Other Morbidities, Diabetes and Cardiopaths, as shown in figure 6.

```
cardiopata
  N                426.0 1393.0
  S                 84.0  463.0
  [total]          510.0 1856.0

hematologia
  N                493.0 1853.0
  S                 17.0     3.0
  [total]          510.0 1856.0

sindrome_down
  N                505.0 1847.0
  S                  5.0     9.0
  [total]          510.0 1856.0

hepatica
  N                507.0 1840.0
  S                  3.0    16.0
  [total]          510.0 1856.0

asma
  N                489.0 1833.0
  S                 21.0    23.0
  [total]          510.0 1856.0

diabetes
  N                442.0 1460.0
  S                 68.0   396.0
  [total]          510.0 1856.0
```

Figure 6: Results after applying the algorithm

Source: The Author

The Weka tool makes it possible to export to other result formats such as HTML, in which the generated model and test can be analyzed side by side, as shown in figure 8 below:

Predictions for dataset QueryResult

inst#	actual	predicted	error	prediction
1	2:OBITO	2:OBITO		0.671
2	2:OBITO	2:OBITO		0.922
3	2:OBITO	2:OBITO		0.611
4	2:OBITO	2:OBITO		0.875
5	2:OBITO	2:OBITO		0.952
6	2:OBITO	2:OBITO		0.767
7	2:OBITO	2:OBITO		0.954
8	2:OBITO	2:OBITO		0.888
9	2:OBITO	2:OBITO		0.851
10	2:OBITO	2:OBITO		0.905
11	2:OBITO	2:OBITO		0.936
12	2:OBITO	2:OBITO		0.895
13	2:OBITO	2:OBITO		0.734
14	2:OBITO	2:OBITO		0.783
15	2:OBITO	2:OBITO		0.554
16	2:OBITO	2:OBITO		0.748
17	2:OBITO	2:OBITO		0.929
18	2:OBITO	2:OBITO		0.92
19	2:OBITO	2:OBITO		0.921
20	2:OBITO	2:OBITO		0.895
21	2:OBITO	2:OBITO		0.902
22	2:OBITO	1:CURA	+	0.501
23	2:OBITO	2:OBITO		0.855
24	2:OBITO	2:OBITO		0.752
25	2:OBITO	2:OBITO		0.967
26	2:OBITO	2:OBITO		0.917
27	2:OBITO	2:OBITO		0.862
28	2:OBITO	2:OBITO		0.833
29	2:OBITO	2:OBITO		0.917
30	2:OBITO	2:OBITO		0.955
31	2:OBITO	2:OBITO		0.965
32	2:OBITO	1:CURA	+	0.657
33	2:OBITO	1:CURA	+	0.68
34	2:OBITO	2:OBITO		0.783
35	2:OBITO	2:OBITO		0.861
36	2:OBITO	2:OBITO		0.936
37	2:OBITO	2:OBITO		0.879
38	2:OBITO	2:OBITO		0.955
39	2:OBITO	2:OBITO		0.86
40	2:OBITO	2:OBITO		0.802
41	2:OBITO	2:OBITO		0.993
42	2:OBITO	2:OBITO		0.882
43	2:OBITO	2:OBITO		0.771
44	2:OBITO	2:OBITO		0.907
45	2:OBITO	2:OBITO		0.964
46	2:OBITO	2:OBITO		0.893
47	2:OBITO	2:OBITO		0.988
48	2:OBITO	2:OBITO		0.94
49	2:OBITO	2:OBITO		0.936
50	2:OBITO	2:OBITO		0.567
51	2:OBITO	2:OBITO		0.897
52	2:OBITO	2:OBITO		0.968
53	2:OBITO	2:OBITO		0.906
54	2:OBITO	2:OBITO		0.822
55	2:OBITO	2:OBITO		0.865
56	2:OBITO	2:OBITO		0.974
57	2:OBITO	2:OBITO		0.75
58	2:OBITO	2:OBITO		0.941
59	2:OBITO	2:OBITO		0.853
60	2:OBITO	2:OBITO		0.823
61	2:OBITO	2:OBITO		0.783
62	2:OBITO	2:OBITO		0.859
63	2:OBITO	2:OBITO		0.867
64	2:OBITO	1:CURA	+	0.718
65	2:OBITO	2:OBITO		0.833
66	2:OBITO	2:OBITO		0.778
67	2:OBITO	2:OBITO		0.992
68	2:OBITO	2:OBITO		0.982
69	2:OBITO	2:OBITO		0.927
70	2:OBITO	2:OBITO		0.888
71	2:OBITO	2:OBITO		0.797
72	2:OBITO	2:OBITO		0.811
73	2:OBITO	2:OBITO		0.973
212	1:CURA	2:OBITO	+	0.568
213	1:CURA	2:OBITO	+	0.921
214	1:CURA	2:OBITO	+	0.905
215	1:CURA	2:OBITO	+	0.879
216	1:CURA	2:OBITO	+	0.743
217	1:CURA	2:OBITO	+	0.569
218	1:CURA	2:OBITO	+	0.675
219	1:CURA	2:OBITO	+	0.64
220	1:CURA	1:CURA		0.725
221	1:CURA	1:CURA		0.888
222	1:CURA	2:OBITO	+	0.649
223	1:CURA	2:OBITO	+	0.877
224	1:CURA	1:CURA		0.888
225	1:CURA	2:OBITO	+	0.745
226	1:CURA	2:OBITO	+	0.939
227	1:CURA	2:OBITO	+	0.615
228	1:CURA	2:OBITO	+	0.825
229	1:CURA	2:OBITO	+	0.908
230	1:CURA	2:OBITO	+	0.765
231	1:CURA	2:OBITO	+	0.841
232	1:CURA	2:OBITO	+	0.614
233	1:CURA	1:CURA		0.933
234	1:CURA	2:OBITO	+	0.957
235	1:CURA	1:CURA		0.632
236	1:CURA	2:OBITO	+	0.647

Figure 8: Comparison of the Generated Model with the Test

Source: The Author

The hit rate refers to the number of instances correctly classified divided by the total number of instances, which is necessary when it comes to predictive models, the higher the hit rate, the greater the efficiency of

the database in the algorithm. A value considered ideal for a hit rate should be between 70% to 100% (BORGES, 2006). Therefore, it is necessary to analyze the efficiency of each technique in the scenario in which it will be applied, to verify if there is precision and reliability in the results with confidence (NASCIMENTO, 2017).

4. FINAL CONSIDERATIONS

This research had as its starting point the importance of the concepts of KDD, which were approached and applied in this work. This model requires attention to each of the phases that integrate it, because the success of a phase depends on the good development of the previous steps. Thus, the KDD was useful in replacing the traditional forms of analysis.

The stage that involved the registration of cases in the official system of the Ministry of Health, was necessary to develop planning strategies, because by analyzing the information on contamination records that occurred in Manaus, indicators can be generated for new strategies based on the health conditions of the people diagnosed with comorbidities.

In this sense, the efficiency of the applied model reached 81%, since the results presented with the extraction of the consistent standards generated useful and valuable information for coping with COVID. This is because, based on the experience presented here, it was possible to produce studies and reports that are really useful for treating patients more effectively.

However, after the application of the algorithm in this database, it was concluded that the Naive Bayes algorithm was efficient in the final generation of the model.

Therefore, this research presents itself as a contribution to future or more complex studies on data mining in the SIVEP-Gripe database..

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Agronomic performance and physicochemical characteristics of onion genotypes under different spacing in the humid Amazonian tropics

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Abstract

The Southwest region of Pará state, Brazil, imports 100% of all onion consumed from other regions of the country, which generates market dependence and raises the product's costs. The present study investigated parameters related to germination, agronomic performance and postharvest characteristics of five onion cultivars at different planting densities. The experiment was conducted in two stages. In the first, in a greenhouse, the germination kinetics was evaluated. In the second, in the field, the seedlings were transplanted into beds. The experimental design was in complete randomized blocks in a 5 x 3 factorial scheme with three replications. The treatments consisted of the combination of five cultivars (Mata Hari, Dulciana, Cimarron, NUN 1205-F1 and Vale Ouro IPA 11) and three line spacing (20, 30 and 40 cm) 8 cm between plants. As for the germination rate (GR), the results allowed to highlight the cvs. Cimarron and Vale Ouro IPA 11 with an 80.55% and 77.77% of GR, respectively. There was a significant difference for total bulb productivity, highlighting Vale Ouro IPA 11 in the 8 x 20 cm spacing. For the bulb diameter, cv. Vale Ouro IPA 11 obtained the best results in all classes. In the average weight of the bulbs,

cv. Vale Ouro IPA 11 in the 8 x 40 cm spacing was the best treatment with 60.77g. As for total soluble solids, cv. Vale Ouro IPA 11 presented °Brix higher than the others, being significant at 1%. These results demonstrate that it is possible to produce quality onions in the Southwest region of Pará, which would reduce prices, since all commercialized onions come from regions outside the state.

Keywords: *Allium cepa* L., bulbs, climate adaptation, planting density, sensory analysis; post-harvest.

1. Introduction

In Brazil, the onion (*Allium cepa* L.) is considered the third most important vegetable from an economic point of view, supplanted only by tomatoes and potatoes (Santos et al., 2018). World production data show that 98 million tons were produced in 2016, with an average productivity of 16.23 t ha^{-1} (FAO, 2018). In 2017, the national average productivity was 31.2 t ha^{-1} (IBGE, 2019).

Onion cultivation is of great socioeconomic importance in the country, since it is cultivated by small producers and demands a large amount of labor, generating employment and income and maintaining producers in the rural area (Resende and Costa, 2009; Lima et al., 2011a). In addition to being an extremely versatile plant and having good acceptance due to its spicy flavor, nutritional and medicinal value (Kale and Ajjappalavara, 2015).

In Brazil, onion production stands out in the South region with the states of Santa Catarina and Rio Grande do Sul, the Southeast region, mainly the states of São Paulo and Minas Gerais and the Northeast, in the São Francisco Valley, with the states of Pernambuco and Bahia as the largest producers (IBGE, 2019; Aline et al., 2020).

The productivity and quality of onion bulbs are associated with genetic, climatic and phytotechnical factors (Gonçalves et al., 2019). In onion culture, the choice of cultivar is conditioned by environmental factors, especially photoperiod and temperature, characteristic of each region, which favors the bulbification process. However, through management practices, it is sought to guarantee conditions that help the cultivar adopted to express its maximum potential, in order to meet the desirable productive characteristics for commercialization (Menezes Junior and Vieira Neto, 2012).

Among the factors of agronomic management that determine the success of commercial bulb production, the establishment of the ideal population of plants per hectare for each cultivar and cultivation system stands out (Baier et al., 2019). The use of higher or lower population densities directly influences several parameters such as productivity, diameter, fresh mass of the bulbs and their classification, which will reflect on the commercial value and profitability of the cultivation (Menezes Junior and Vieira Neto, 2012). In this context, several studies have been conducted in Brazil to demonstrate that planting density is extremely important in the quality of production (Menezes Junior and Vieira Neto, 2012; Henriques et al., 2014; Harms, et al., 2015; Santos et al., 2018).

Another considerable factor that benefits the onion's productivity is the way of producing seedlings. Crops established with tray seedlings, in addition to the shorter cycle, generally require less crop treatment, lower seed costs, more vigorous seedlings and better uniformity. Allied to this, there is the possibility of

producing more than one seedling per tray cell, which contributes to reducing the cost per seedling produced (Nascimento et al., 2003).

Maximum and minimum temperatures are also important. Onion seeds germinate over a wide temperature range, however, temperatures above 30ºC affect both the germination percentage and all other parameters of germination kinetics (Pinheiro et al., 2014). The occurrence of temperatures above 30ºC can accelerate the formation of bulbs in the field (Costa et al., 2012). Thus, a warmer climate can be favorable for onion production. On the other hand, temperatures below 15ºC, in addition to delaying bulbification, can cause changes in bulb morphology (Wurr et al., 1998).

Water supply is another important factor in onion crops, as irrigation is considered an essential tool to increase its yield (Carvalho et al., 2018). Severe irrigation deficits applied in the growth and bulbification stages, negatively affect biomass production and productivity (Abdelkhalik et al., 2019). Drip irrigation allows greater efficiency in the application of water and fertilizers and allows for high-frequency irrigations, thus maintaining the soil water potential (SWP) relatively constant compared with furrow irrigation (Shock et al., 2000).

As with most vegetables, onion quality is closely linked to genetic factors that affect the variability of many characteristics, predisposing differences between cultivars (Sekara et al., 2017). External appearance, bulb size, color, flavor, firmness and chemical composition are genetic parameters. These attributes are determined, in part, by the genotype, by cultural treatments in the pre-harvest, by the appropriate harvest time and by post-harvest treatments, which aim, mainly, to guarantee the physical integrity and maintenance of the chemical quality of the bulbs (Finger and Casali, 2002).

Among the physical-chemical characteristics used to assess the post-harvest quality of vegetables, the soluble solids content, the total titratable acidity and the pH stand out (Chitarra, 1994). One of the most important characteristics of onion for industrialization, and in particular for the production of dehydrates, is its total solids content.

In addition to the temperature, the photoperiod is important for the bulbification process. Onion cultivars are called short days, requiring less than 12 hours of light, intermediate, requiring 13 to 14 hours and days between 15 and 16 hours (Sekara et al., 2017). Photoperiod combined with temperature, genetic factors and post-harvest qualities are important when you want to introduce onion cultivars in a given region.

The cultivation of onions represents a necessity for Pará, since the state supplies itself with products from other regions, mainly from the Northeast, which results in a high price offer to the consumer. With the construction of the Belo Monte Hydroelectric dam, demand for vegetables increased, making the region even more dependent on supply and prices. In addition, Brazil is not self-sufficient in onion production. The high consumption of this bulb during the year, associated with the smaller harvests in some producing regions, in certain periods of the year, makes its import essential. Until 2011, the regular share of imported onion in the Brazilian supply was 15%, mainly from China and Argentina (Camargo and Camargo, 2017).

Given the above, the objective was to evaluate the adaptation of onion genotypes in conditions of humid Amazonian tropics, related to seedling production, productivity, bulb classification and post-harvest characteristics at different densities using drip irrigation, in a production cycle.

2. Material and Methods

2.1 Experiment location and seedling preparation

The experiment was carried out from July to December 2016, in the experimental area of the Casa Familiar Rural in Altamira-PA, located in the following geographical coordinates: 03º09'28.6 "S (lat.) and 052º16'40.6" W (long.), altitude of 175 m. The climate of the region, according to the Köppen classification, is of the equatorial type Am (Dubreuili, et al., 2019), presenting two well-defined climatic seasons: the drought period from July to December corresponding to "summer" and the rainy period from January to June that corresponds to "winter", with annual rainfall around 2.123 mm (Silva et al., 2009). Five cultivars of onions were used Table 1. The average maximum temperature during the field study reached 34.5ºC and the average minimum temperature was 24.4ºC.

Table 1. Cultivars of onions used in the experiment, Altamira-PA

Cultivar[1]	Type of cultivar	Bulb shape	Cycle[2]	Place of origin	Harvest
Mata Hari	Hybrid	Oblong	Super early	South Africa	2015
Dulciana	Hybrid	Oblong	Super early	South Africa	2015
Cimarron	Hybrid	Oblong	Super early	Itaty	2015
NUN 1205 - F1	Hybrid	Oblong	Super early	South Africa	2015
Vale Ouro IPA 11	Variety	Oblong	Super early	Brazil	2015

[1]Onion cultivars obtained in partnership with Casa Agropecuária Agrosanta and the Bayer S.A. Company

[2]Cultural cycle between 90 and 130 days.

The seedlings were prepared in a greenhouse covered with 150 micron plastic film and conducted in expanded polystyrene trays of 128 cells, with a volume of 32 cm³, containing 80 L of fine coconut fiber as a substrate, 20 L of indigenous black earth, 300 g of castor cake, 250 g of osmocote and 150 g of phosphate fertilizer yorin master. Three seeds per cell were sown at an inch of depth. The nursery was irrigated twice with a manual watering can.

For the study, three trays of each cultivar were sown. For each treatment, a completely randomized design with three replications was adopted. In each repetition, the eight central cells of the trays were considered for analysis, totaling 72 seedlings per treatment. Variables of percentage and kinetics of emergence and seedling growth were evaluated for each onion cultivar.

The Germination Rate (GR) was evaluated from the daily seedling emergency count for 11 days, at the same time. Emerging seedlings were those that showed visible hypocotyl emission above the substrate. From the daily evaluations, the Average Germination Time (AGT), the Average Germination Speed (AGS) and the Germination Speed Index (GSI) were estimated.

AGT is the average time, in days, required for seeds to germinate (Labouriau, 1983; Santana and Ranal, 2000). The AGS was calculated to be the inverse of the AGT, through daily counts (Labouriau, 1970; Santana and Ranal, 2000). The GSI, a measure widely used to predict the relative vigor of seed samples, was calculated from the sum of germinated seeds divided by the time required for this to occur (Maguire,

1962; Santana and Ranal, 2000). The results were subjected to analysis of variance (F test), comparing the means by the Scott-Knott test, at the level of 5% probability using the program Assistat Beta version 7.7 (Silva and Azevedo, 2016). The data for GR and GSI were transformed into a square root. The other data did not undergo transformation.

2.2 Field experiment setup

The soil of the area, Yellow Latosol, sandy loam, terrace phase, sandy texture, presented, according to the soil analysis in the layer from 0 to 20 cm deep, the characteristics: pH in H_2O = 4.7; organic matter = 1.7 dag kg; P = 3.0 mg dm^{-3}; K = 31 mg dm^{-3}, Zn = 0.2 mg dm^{-3}, Cu = 0.9 mg dm^{-3}, B = 0.53 mg dm^{-3}, S = 9.0 mg dm^{-3}e, in cmolc dm^{-3}, Ca^{2+} = 1.1; Mg^{2+} = 0.3; Al^{3+} = 0.7; H + Al = 4.2; SB = 1.5; CTC (t) = 2.2; CTC (T) = 5.7 and V = 26.9%.

The area used for the experiment was 200 m². First, the area was cleared and then the liming was carried out on 07/21/2016 with virgin dolomitic lime Geox, a material that has 60% CaO and 30% MgO and PRNT = 180%, in the dose of 1.5 t ha, aiming at raise the pH to 6.0. The limestone was distributed on the soil surface and incorporated with the aid of a cultivator at a depth of 20 cm, 30 days before transplantation. The construction sites were constructed in three different dimensions (0.80 x 15 m; 1.20 x 15 m and 1.60 x 15 m) with 0.20 m high, about 0.70 m apart from each other. The basic fertilization was done with 300 kg ha^{-1} of P_2O in the form of triple superphosphate, in addition to 5 kg m^{-2} of tanned pig manure in each site eight days before transplanting. The characteristics of swine manure are shown in Table 2.

Table 2. Result of analysis of swine solid organic fertilizer

ANALYZED PARAMETERS			
Humidity at 60-65 ^{0}C (%)	14.94	Phosphor (P_2O_5) (%)	2.25
pH in $CaCl_2$	7.82	Calcium (Ca) (%)	2.08
Total Organic Matter (%)	80.6	Potassium (K_2O) (%)	1.58
Compostable Organic Matter (%)	54	Magnesium (Mg) (%)	0.56
Organic Carbon (%)	30	Sulfur (S) (%)	0.57
Relationship C/N	11/1	Iron (Fe) (%)	0.58
Nitrogen (N) (%)	2.76	Zinc (Zn) (ppm)	149
Manganese (Mn) (ppm)[1]	176.5	Copper (Cu) (ppm)	107.5
Boron (ppm)	18.4		

[1] ppm = parts per million.

The experimental design used in the field was in randomized blocks, in a 5 x 3 factorial scheme, comprising five onion genotypes Table 1 and three spacing between lines (20, 30 and 40 cm) and 8 cm between plants, with three replications.

The seedlings were transplanted 43 days after sowing (DAS). The stand for each cultivar was made using a digital pachymeter and a scale to evaluate the parameters: leaf length and diameter of the pseudostem. On average, the seedlings went to the field measuring 3 mm in diameter in the pseudostem and 19 cm in height, obtained by measuring between the ground level and the end of the largest leaf.

Four lines were implanted per bed, spaced 20, 30 and 40 cm between them and 8 cm, between plants, with plots of 0.80 m^2 (1.00 m x 0.80 m), 1.20 m^2 (1.00 m x 1.20 m) and 1.60 m^2 (1.00 m x 1.60 m) with 48 plants distributed, making a population of 600, 400 and 300 thousand plants per hectare, respectively.

At 15 days after transplanting (DAT), 3.0 kg ha^{-1} of boron (boráx) and 4.0 kg ha^{-1} of zinc (FTE - 12 granulated) were added at a depth of 5 cm together with fertilization of coverage with 40 kg ha^{-1} of N (Urea) and 50 kg ha^{-1} of K (Potassium chloride), repeated at 30 and 45 DAT based on soil analysis and Embrapa recommendations (Cravo et al., 2007).

The adopted irrigation system was drip. The self-compensating emitters were of the *in-line* type, model NAAN PC with nominal flow of 1.6 L h^{-1} and spaced apart at 0.30 m. The drip tube was positioned in the plot, in order to meet the two rows of plant, working with a service pressure of 6 m of water column.

The control of pests and diseases, as well as the elimination of invasive plants was carried out while representing a threat to productivity. Since the manual weeding of the beds was all manual. For the prevention of diseases such as purple spot (*Alternaria porri* (Ellis) Cif.), Burning of the tips (*Botrytis squamosa*) and downy mildew (*Peronospora destructor* (Berk) Casp. Ex Berk), two applications were made with 20% mancozeb + ditiocarbamate 80% (Dithane®) in weekly sprays, in the dosages of 1.5 g L^{-1} of water. The thrips control (*Thrips tabaci*) was performed with two applications of Deltametrine (Decis 25 CE®), in the dose of 0.3 ml L^{-1} of the commercial product.

To determine productivity, the 16 central plants of each plot of a total of 48 that formed the repetitions were considered, with 8 plants from each central row. Discarding the plants that formed the border, with two plants from each row at the beginning and end of each plot and the two outer rows.

The harvest was carried out after the vegetative development of the bulbs, when the plants had more than 60% of "snap" that is, tipping of the aerial part, on average, 110 DAS. The bulbs were harvested manually, remaining for two days in the field and, subsequently, taken for “curing” in the shade and with good ventilation, where they remained for ten days until drying. After the "curing" process, the bulbs were weighed and classified into five classes, based on the transverse diameter: ≤35 mm, class I; > 35≤50 mm, class II; > 50≤70 mm, class III; > 70 ≤90 mm, class IV; > 90 mm, class V (Brasil, 1995). The total production of bulbs was determined by the sum of all classes and the commercial production by the sum of classes with a diameter greater than 35 mm.

2.3 Post-harvest analysis

After 15 days of the procedure of weighing and classification of the bulbs, some post-harvest parameters were verified to better differentiate the materials. These procedures were performed at the Post-Harvest Physiology and Technology Laboratory of the Faculty of Agronomic Engineering at UFPA in Altamira. The ºBrix content of each material was calculated, as well as the Total Titratable Acidity (TTA) and the respective pH.

Soluble solids (SS) - To find TSS (% in °Brix - Sugar content of each sample) a numerical scale refractometer was used. Two drops of juice were placed on the device's display and the results were expressed in % soluble solids (or °Brix).

Total Titratable Acidity (TTA) - It was determined by titration with 0.1N sodium hydroxide (NaOH) using a volumetric procedure. To the sample diluted in water (0.5 mL of extract from the samples of each

genotype in 50 mL of distilled water) and for titration 3 drops of phenolphthalein; 0.1N NaOH was added slowly to the container by means of a burette, until the color of the solution changed to slightly pink; the volume used in the base was duly noted to calculate the percentage of organic acid in the sample according to the formula TTA = $V.f_a.f_b$ / TE where: TTA = total titratable acidity in g / 100 ml or %; V = spent volume of 0.1N NaOH in the titration; f_a = 0.1N alkali factor of the acid; f_b = NaOH correction factor and TE = test intake, that is, the amount of juice used for the titration in ml (Brasil, 1986).

Hydrogenionic potential (pH) - was found from the use of a digital bench pH meter. In this case, he used the onion juice without dilution in distilled water.

For all post-harvest data, he used three onions from each cultivar, which required 10 g of macerated onion of class II (transversal diameter between 35 to 50 mm) and three different repetitions. Statistical analyzes were performed with the assistance of the Assistat Beta version 7.7 program (Silva and Azevedo, 2016).

3. Results

3.1 Percentage variables and kinetics of seedling emergence and growth

All cultivars belong to the 2015 harvest, as shown in Table 1. Regarding germination, the values shown on the packaging labels were 90% for Mata Hari, 89% for Dulciana, 90% for Cimarron, 90% for NUN 1205 - F1 and 90% for Vale Ouro IPA 11. Table 3 shows that there was a significant difference at the level of 1% between cultivars for GR and GSI. For the other parameters analyzed, there was no significant difference.

Table 3. Anova summary for Germination Rate (GR), Germination Speed Index (GSI), Average Germination Time (AGT) and Average Germination Speed (AGS) of five onion cultivars under greenhouse conditions

		Average square			
Variation Sources	FD	GR	GSI	AGT	AGS
Treatment	4	1516.20**	1.4030**	0.81372^{ns}	0.00015^{ns}
Waste	10	244.21	0.2340	0.78321	0.00012
Total	14				
CV (%)		25	25.2	10.49	8.99
X^2		16.85*	18.16*		

** Significant at the 1% probability level ($p < 0.01$); * significant at the 5% probability level ($0.01 > p < 0.05$); ns not significant; CV. Coefficient of variation.

The results presented allowed to highlight the cvs. Cimarron and Vale Ouro IPA 11 with GR of 80.55% and 77.77%, respectively. The cultivar Mata Hari, with only 25% GR, had the worst result in this parameter, while the cultivars Dulciana and NUN 1205 - F1 with 59.72% and 69.44%, respectively, were classified as intermediate (Table 4).

Table 4. Germination Rate (GR), Germination Speed Index (GSI), Average Germination Time (AGT) and Average Germination Speed (AGS) of five onions cultivars in greenhouse conditions in Altamira-PA

Treatments	GR	GSI	AGT	AGS
Mata Hari	25.00 b	0.803 b	8.948 a	0.115 a
Dulciana	59.72 a	1.815 a	8.431 a	0.119 a
Cimarron	80.55 a	2.258 a	8.884 a	0.113 a
NUN 1205 - F1	69.44 a	2.126 a	8.225 a	0.122 a
Vale Ouro IPA 11	77.77 a	2.595 a	7.675 a	0.130 a

The means followed by the same letter do not differ statistically. The Scott-Knott test was applied at the level of 5% probability ($\alpha \leq 0.05$).

For the GST, the results were significant at the 5% probability level. The highest GST was found in the cultivar Vale Ouro IPA 11, with 2,595 seedlings day^{-1}, corresponding to 13.9% per day. Also, according to Table 4, the cultivars Dulciana, Cimarron, Num 1205 - F1 and Vale Ouro IPA 11 formed a group, whose GSI is between 1.815 to 2.595. In the other group, the Mata Hari genotype had a GSI of 0.803. There was no statistical difference for the AGT and AGS parameters between onion genotypes.

Regarding the stand formation parameters of each cultivar, on average, the seedlings went to the field measuring 19 cm in height and 3 mm in diameter in the pseudostem. Vale Ouro IPA 11 stands out for its uniformity, being the best seedling stand, followed by Dulciana (Table 5).

Table 5. Leaf Length (LL) and Pseudostem Diameter (PD) ratio of five onion cultivars in house conditions of vegetation in Altamira-PA

Cultivars	LL (cm)	PD (mm)
Mata Hari	17.62 a	2.66 b
Dulciana	18.57 a	3.02 a
Cimarron	18.77 a	2.72 b
NUN 1205 - F1	19.00 a	2.72 b
Vale Ouro IPA 11	19.90 a	3.11 a
CV (%)	18.19	16.55

The means followed by the same letter do not differ statistically. The Scott-Knott test was applied at the level of 5% probability ($\alpha \leq 0.05$). CV. Coefficient of variation.

3.2 Onion productivity

There were significant differences for the isolated effect of cultivars on agronomic characteristics, bulb diameter, bulb height, average bulb weight and productivity (Table 6), showing that the cultivars from a genetic point of view are different.

The productivity data indicate that there were significant differences in the interaction between treatments and between cultivars ($p < 0.01$). The cultivar Vale Ouro IPA 11 provided greater productivity in the spacing between lines of 20 cm (30.03 t ha^{-1}). The Mata Hari and Cimarron hybrids with production of 27.59 and 24.86 t ha^{-1}, respectively, in the 20 cm spacing, also presented a production similar to the national average.

The lowest productivity was found in the hybrid Dulciana with 6.81 t ha^{-1} in the spacing of 40 cm between rows (Table 6).

Table 6. Bulb diameter, Bulb height, Fresh bulb mass and Average yield of different onion cultivars, 70 days after transplanting. Altamira-PA

Treatments	Bulb diameter in t ha^{-1}			Bulb height	Fresh bulb mass	Average yield
	≤ 35 mm	>35 ≤ 50 mm	>50 ≤ 70 mm	mm	g	t ha^{-1}
M.H x 20 cm	10.55 a	16.23 b	0.81 b	54.26 b	44.14 b	27.59 a
M.H x 30 cm	8.89 a	4.44 c	0.37 b	51.01 b	32.89 c	13.71 c
M.H x 40 cm	1.87 b	11.23 b	3.74 a	57.18 a	53.90 a	16.84 c
DUL x 20 cm	12.05 a	8.48 c	0.89 b	55.58 b	34.27 c	21.42 b
DUL x 30 cm	6.55 a	0.90 d	0.00 b	48.57 b	17.89 d	7.45 d
DUL x 40 cm	6.08 a	0.72 d	0.00 b	51.33 b	21.79 d	6.81 d
CIM x 20 cm	9.70 a	15.16 b	0.00 b	64.63 a	39.77 b	24.86 a
CIM x 30 cm	7.66 a	2.78 d	0.00 b	58.80 a	25.06 d	10.44 d
CIM x 40 cm	6.46 a	6.46 c	0.92 b	62.98 a	44.28 b	13.84 c
NUN x 20 cm	10.67 a	1.33 d	0.00 b	53.89 b	19.21 d	12.01 c
NUN x 30 cm	9.20 a	2.93 d	0.00 b	59.59 a	29.10 c	12.12 c
NUN x 40 cm	6.20 a	3.40 d	0.00 b	58.73 a	30.71 c	9.60 d
IPA 11 x 20 cm	1.88 b	26.28 a	1.88 b	56.03 b	48.05 b	30.03 a
IPA 11 x 30 cm	3.98 b	12.74 b	0.80 b	51.58 b	42.06 b	17.52 c
IPA 11 x 40 cm	0.41 b	14.04 b	4.54 a	57.41 a	60.78 a	18.99 b
Averages	7.52	14.08	3.72	57.18	43.41	19.79
CV (%)				6.95	19.55	18.32

The means followed by the same letter do not differ statistically. The Scott-Knott test was applied at the level of 5% probability ($\alpha \leq 0.05$). M.H = Mata Hari; DUL = Dulciana; MIC = Cimarron; NUN = NUN 1205 - F1; IPA 11 = Vale Ouro IPA 11. CV. Coefficient of variation.

The average bulb weight (ABW) is commercially important, as it defines the value and directs the type of market to which they are destined (Tavares, 2015). A peculiar characteristic of the onion is that, once the bulb growth phase begins, the growth of the leaves stops. Therefore, the size of the bulb at harvest is greatly influenced by the size and number of leaves on the plant, and it is important that the stimulation of the photoperiod only occurs after the plant has reached a certain degree of growth so that it is able to

produce a large and well-formed (Oliveira et al., 2015). In the experiment there were significant differences for this parameter ($p < 0.01$), the cultivar Vale Ouro IPA 11 with 60.78 g and Mata Hari with 53.90 g, both in the spacing between lines of 40 cm, were the ones that presented the highest ABW. Dulciana being 30 cm between lines, the one with the lowest average weight was 17.89 g (Table 6).

The classification of the bulbs according to the size class is another indicator of the quality of production achieved. The national consumer market prefers medium-sized bulbs, with masses of 80 to 100 g and transversal diameter, varying between 40 to 80 mm (Souza and Resende, 2002). As for the diameter of the bulb, there was a significant effect on classes I, II and III (Table 6). The cultivars with the lowest number of bulbs considered non-commercial (refuse) (Class I) were the cultivars Vale Ouro IPA 11 and Mata Hari. Regarding class II, the highlight is the cultivars Vale Ouro IPA 11 in the three spacing between rows with 26.28 t ha^{-1} (87.5%), 12.74 t ha^{-1} (72.7%) and 14.04 t ha^{-1} (73.9%) and the Mata Hari and Cimarron hybrids, with 16.23 t ha^{-1} (58.8%) and 15.16 t ha^{-1} (61%), respectively, in the 20 cm spacing , of the total productivity for the treatments.

The cultivars Dulciana and NUN 1205 - F1 showed not to be adapted for the region, with a productivity in class II between 0.72 t ha^{-1} (10.6%) for Dulciana and 1.33 t ha^{-1} (11.1%) for NUN 1205 - F1. Only the cultivars Vale Ouro IPA 11 and Mata Hari achieved productivity in class III in all treatments, with Vale Ouro IPA treatments 11 x 40 cm with 4.54 t ha^{-1} (23.9%) and Mata Hari x 40 cm with 3.74 t ha^{-1} (22.2%) of the total productivity, obtaining the best yields among the six treatments, corresponding to the cultivars. For the other classes, productivity was not obtained in any of the cultivars (Table 6).

3.3 Post-harvest characteristics

Regarding the soluble solids of the treatments, there was a great variation between cultivars from 4.61% to 8.15%, where cv. Vale Ouro - IPA 11 had the highest value, being significant at the level of 1% probability (Table 7), followed by the hybrids Mata Hari, Cimarron and Nun 1205 - F1, and with lower performance for Dulciana. The high content of total soluble solids is linked to the high pungency and good storage quality of the bulbs. Another indication related to soluble solids is the maturation stage of the material, that is, higher percentages of ºBrix refers to saying that the cultivar is closer to maturation.

Table 7. Soluble solids, pH and titratable acidity of five onion cultivars produced in Altamira-PA

	POST-HARVEST CHARACTERISTICS		
CULTIVARS	Soluble Solids (°Brix)	pH	Titratable Acidity (%Pyruvic Acid)
Mata Hari	6.51 b	5.65 a	0.30 a
Dulciana	4.61 c	5.70 a	0.26 a
Cimarron	6.23 b	5.25 b	0.28 a
Nun 1205 - F1	5.18 c	5.24 b	0.29 a
IPA 11	8.15 a	5.26 b	0.24 a
Average	6.14	5.42	0.27
CV (%)	12.39	3.48	9.79

The means followed by the same letter do not differ statistically. The Scott-Knott test was applied at the level of 5% probability ($\alpha \leq 0.05$). CV. Coefficient of variation.

As for acidity, there was no significant difference between cultivars, data corrected in square root, maintained the degree of indifferent significance (Table 7).

For the pH, the cultivars Dulciana and Mata Hari had the highest values, standing out from the others in this parameter, with values 5.70 and 5.65, respectively. The one with the lowest pH value was the hybrid NUN 1205 - F1, with 5.24 (Table 7).

4. Discussion

Self-sufficiency in onion production is important because it makes the product more affordable to consumers. The hypothesis was tested that the production of onions in the Southwest region of the state of Pará would be viable, mainly in the dry season that comprises the Amazonian summer.

The results presented allowed to highlight the cvs. Cimarron and Vale Ouro IPA 11 with GR of 80.55% and 77.77%, respectively, with superior physiological potential, very similar to that found by Hölbig et al. (2011), who working with cv. Bola Precoce showed GR ranging from 58 to 88%.

Regarding the Germination Rate, Ramos et al. (2004), suggest the need to carry out as many tests as possible before classifying the lots as to their physiological potential, as each test has a different principle and provides complementary information for the decision regarding the final destination of each seed lot. Still regarding the result of the Mata Hari genotype, which presented a very low GR (Table 4), most of the seeds probably went into dormancy, and the environment and substrate were not conducive to overcoming this, since the seeds that remained at the end of the experiment were considered viable.

Seed dormancy is related to the length of the cycle and rusticity of the species, allowing seeds to remain viable for long periods in the soil, until some favorable environmental condition acts on the physiological mechanisms and provides germination. Other factors like temperature, cultivar, and seasonal change in weather conditions during the vegetation period show significant influence on dormancy of onion (Sharma et al., 2016).

The highest GSI was found in the cultivar Vale Ouro IPA 11, with 2.59 seedlings day^{-1}, corresponding to 13.9% per day, similar to that found by Hölbig et al. (2011) for cv. Early Ball, comprised between 8.5 to 12.8%. Vale Ouro IPA 11 formed a group with Dulciana, Cimarron and Num 1205 with GSIs between 1.81 to 2.59. Mauri et al. (2010), studying the germination of Brocolis (*Brassica oleracea* var. *Italica* L. Plenk) in the conventional system, found the oscillation of the GSI between 2.53 to 4.85 seedlings day^{-1} in different commercial and organic substrates. In a study by Trenhago et al. (2011), evaluating the GSI of garlic (*Allium sativum* L.) in different planting positions, found, on average, 2.05 seedlings day^{-1}.

For AGT, the result was not significant for both treatments (Table 4). However, four of the five treatments, the AGT was above 8 days^{-1}. According to work by Pinheiro et al. (2012) the temperature influenced the AGT of onion seeds, with the shortest germination time of five days for seeds submitted to 25ºC. In the study now presented, the temperature ranged from 28ºC to 42ºC.

According to Carvalho and Nakagawa (2012), the temperature below or above the optimum tends to reduce the speed of the germination process, exposing the seedlings for a longer period to adverse factors, which can lead to a reduction in the total germination. The optimum temperature provides the percentage of maximum germination in a shorter period of time, while maximum and minimum temperatures are restrictive points for seed germination. Onion seeds exposed in the field at temperatures between 10ºC and 30ºC can produce a higher germination percentage, lead to development of normal seedlings (Abu-Rayyan et al., 2012). Carvalho et al. (2015) evaluating the radish (*Raphanus sativus*) AGT found, for one of the varieties 5.2 days^{-1}. Costa et al. (2015), working with onions from cv. IPA 11 found AGT values of 6.49 at 25ºC and 4.19 at 34ºC. In the work in question, the temperature in the greenhouse fluctuated considerably, concluding the experiment at an average of 35ºC.

AGS is the opposite of AGT, that is, the higher the AGT the lower the AGS. In this parameter, there was no significant difference between the treatments studied (Table 4). The highest AGS of treatments was 0.13 day^{-1} of the Vale Ouro IPA 11 genotype and the lowest, 0.11 day^{-1} of Mata Hari. Costa et al. (2015) for a similar temperature situation, they found 0.23 day^{-1} for cv. Vale Ouro IPA 11. Rêgo et al. (2015) analyzing the same cv. Vale Ouro IPA 11 found AGS of 0.16 day^{-1} and 0.17 day^{-1} for different concentrations of CO_2, corroborating the results presented in the present study.

On average, the seedlings went to the field measuring 3 mm in diameter in the pseudostem and 19 cm in height, highlighting Vale Ouro IPA 11 for its uniformity, followed by cv. Dulciana (Table 5). These results demonstrate the possibility of producing onion seedlings under the conditions of the study region.

In terms of productivity, the cv. Vale Ouro IPA 11 with productivity 30.033 t ha^{-1} in the spacing between lines 20 cm (Table 6), well above the national average, estimated at 27.844 t ha^{-1} (IBGE, 2016). A result similar to that found by Lima et al. (2011b) with 33.81 t ha^{-1} for the same cv. Vale Ouro IPA 11 in conditions of the state of Rondônia, corroborating with the data of this research.

This significant difference in productivity between the genotypes demonstrates that the interaction between genotype x environment (GxE) was decisive in filling the bulb and, consequently, in the final production. Biotic factors such as photoperiod and temperature are decisive, given that for bulbification, the length of the day must decrease and the temperature increase, but the length of the day must be sufficient. Precise temperature control is therefore especially important when studying different growth phases of onion (Sekara et al., 2017; Khosa et al., 2018). This interaction effect can even lead different genotypes evaluated to a huge diversity of patterns and results (Coimbra et al., 2009).

Interaction (GxE) arises when a genotype responds differently to environmental variations, and in this situation, the best genotypes in one location may not necessarily be the best in other locations. Thus, the cultivar choice is linked to local climatic conditions (Sekara et al., 2017). This explains why genotypes such as Dulciana and NUN 1205 - F1 do not achieve the same performance as in other regions.

In Brazil, there has been little research on hybrids studied in this work. Tavares (2015) studying the hybrids NUN 1205 - F1, Dulciana and Cimarron obtained satisfactory results both for productivity and for average bulb mass, with transplantation in July, in the state of Tocantins. Reghin et al. (2004) when evaluating bulb yield of Crioula and Bola Precoce cultivars, using 40 cm spacing between lines and four different spacing between plants (5, 8, 11 and 14 cm) observed that, in the lowest density, there were no

differences between the two cultivars in terms of productivity and proportion of marketable bulbs, however, found different behavior between genotypes in other planting densities.

The data referring to the ABW showed statistical differences with Vale Ouro IPA 11 and Mata Hari with the best averages in the 40 cm spacing (Table 6). This difference in ABW is explained by the increase in the population of plants as well as by the genotypic characteristic of each cultivar. Meneses Junior and Vieira Neto (2012) found that in the densities employed for the cultivar EMPASC 355-Juporanga, the smallest ABW (50.37 g bulb^{-1}) was obtained in a population of approximately 503 thousand plants ha^{-1}, while the largest ABW (114.60 g bulb^{-1}) was observed in populations of 200 thousand plants ha^{-1}. In the experiments now presented, treatments with 300 thousand plants ha^{-1} (greater spacing) obtained greater ABW, corroborating with the literature.

The cultivars that showed the lowest number of bulbs considered non-commercial (Class I refuse) were the cultivars Vale Ouro IPA 11 and Mata Hari ranging from 0.41 to 1.87 t ha^{-1}, in percentage this represents 2.2% to 11.1%, a result very similar to that of Lima et al. (2011b) for the cultivar Vale Ouro IPA 11, with 1.07 t ha^{-1} of refuse. The quantities of scrap bulbs decreased simultaneously with the increase in spacing between lines, with the exception of Vale Ouro IPA 11 in the 30 cm spacing.

Smaller spacing increases productivity per cultivated area, but, in most treatments, the average weight of the bulbs has decreased. Resende et al. (2005), observed an inverse relationship between the increase or reduction of line spacing in onion bulb productivity, that is, as the density of plants per hectare increases, reducing these spacing, a reduction in the size of the plant occurs simultaneously bulb. Clearly observed in the study with respect to the 40 cm spacing between lines. For all treatments there was a greater increase in ABW. However, the highest total productivity occurred in the spacing between 20 cm lines, corroborating with the data presented.

Regarding TSS, there was a significant difference with cv. Vale Ouro IPA 11 with values averaging 8.15% of ºBrix standing out and cv. Dulciana presenting the lowest value 4.61% of ºBrix (Table 7). The high TSS content is linked to the high pungency and good storage quality of the bulbs. Another indication related to TSS is the stage of maturation of the material, that is, higher percentages of ºBrix refers to saying that the cultivar is closer to maturation. Grangeiro et al. (2008), when working with the cultivar Primavera, found 9.3% of TSS, that is, results very similar to those presented in this work.

There was no significant difference for the parameter Total Titratable Acidity-TTA (% of pyruvic acid). The highest average was of cv. Mata Hari with 0.30% and the lowest of CV Vale Ouro IPA-11 with 0.24%. Chagas et al. (2004), evaluating the cultivars Baia Periforme, Crioula, Granex 33, Jubileu, Pira Ouro and Texas Grano-502 in Southern Minas Gerais, found results similar to those observed in this study. The highest acidity was found in the Crioula and Pira Ouro cultivars, with 0.370% and 0.315%, followed by the Jubileu and Baia Periforme cultivars, with 0.308% and 0.305%, respectively. The lowest values were found in the cultivars Texas Grano 502 and Granex 33, with 0.190% and 0.195%, respectively.

The pH range varied between 5.24 and 5.70 (Table 7). In a similar study, Schunemann et al. (2006) found that the physical-chemical and chemical results varied between cultivars, being in the pH range of 5.44 to 5.61, corroborating with this research. Rocha et al. (2015), when analyzing the cv. of onion Vale Ouro IPA 11 in cube, found for Total Titratable Acidity and Total Soluble Solids values of 0.24% and 9.46,

respectively, similar to this study. Resende et al. (2010), comparing organic and conventional cultivation of onions, find results similar to this research for TTA and TSS for some cultivars.

5. Conclusions

The results obtained allow us to conclude that there is a possibility of producing seedlings and onions under the conditions of the study region. Total productivity increased linearly with plant density, providing maximum total productivity, even higher than the national average. Waste production decreased linearly with increased spacing. The same was true for the average bulb weight. The bulb diameter was another factor influenced by the spacing between lines. Some highly productive hybrids did not achieve the same agronomic performance in the region's climatic conditions. However, the highlight is the cultivar Vale Ouro IPA 11, which obtained productivity above the national average and good adaptation to regional conditions. Post-harvest data showed that all cultivars are within the recommended standard for onion cultivation, and it is possible to recommend Mata Hari cultivars and especially Vale Ouro IPA 11 for commercial plantations in the region.

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Effects of Multiple representations and Problem- solving learning strategies on Physics students' problem-solving abilities

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Abstract

Student's learning in physics takes many forms. Equations, diagrams, graphs and words all can be used to describe physical phenomena. Constructing descriptions of physical situations with these representations and focusing on their correct usage led to this study which investigated physics students' knowledge of multiple representations and problem-solving abilities using multiple representations learning strategy and problem-solving learning strategy as an intervention. The pretest-posttest, control group quasi-experimental design with a 3x2x3 factorial matrix was used. A total of 294 Senior Secondary School-two (SSII) Physics students selected from six purposively sampled co-educational schools in Education Districts V of Lagos State formed the sample. Test of Knowledge of Multiple Representations Abilities in Projectiles and Equilibrium of forces (TKMRA-PE), Multiple Representations Abilities Assessment Instrument (MRAI) and Problem-Solving Assessment Instrument (PSAI). The reliability coefficient of the TKMRA-PE, MRAI, and PSAI were 0.83, 0.75 and 0.70 respectively. Data gathered were subjected to statistical techniques of Analysis of Covariance (ANCOVA) at 0.05 level of significant. Findings from the results showed significant effect of multiple representations learning strategies on problem-solving abilities; $F_{(2, 291)} = 4.440$; $p < 0.05$, $\eta^2 = 0.030$. *The descriptive statistics revealed the magnitude of problem-solving abilities across the groups. Students exposed to multiple representations learning strategy had the highest problem-solving abilities (x= 3.83),than their counterparts in problem-solving learning strategy(x = 29.4),and those conventional strategy group had the least problem-solving abilities(x =22.3).The finding showed that irrespective of gender and ability level, multiple representations and problem-solving strategies facilitate learning and should be recommended for teaching and learning of physics in senior secondary schools in Nigeria.*

Keywords: Multiple representations, problem-solving, representational abilities, problem-solving abilities

1. Introduction

Multiple representations provide an empowering learning tool that support students' understanding of physics concepts, and it is impossible to learn physics without representations. We always need text, formulas, symbols, graphs, and/or figures to learn physics. Multiple representations provide an effective

learning strategy which can lead to significant improvement of students' conceptual understanding of physics concepts (Opfermann et al., 2017; Treagust et al., 2018). Multiple representations in learning physics can be used to minimize student difficulties in learning and develop the skills of representing problems such as constructing and using mathematical representations, words, graphs, diagrams, pictures, tables, equations, and symbol manipulation (Laras et al., 2015).

Multiple representations represent the role of helping students in developing a better understanding because a concept presented using multiple representations can increase deep understanding so that students can build a complete understanding of the related concepts. Multiple representations enable learners to see complex ideas in a way and then to apply these complex ideas to learn effectively (Masrifah et al, 2020).

Multiple representations are very supportive for use in conceptual learning, such as Physics, because multiple representations place greater emphasis on understanding concepts and qualitative reasoning in learning (Dufresne, Grace, & Leonard 1997). This is supported by Kohl, Rosegrant, & Finkelstein (2007) who states that multiple representations learning can be considered as the key to learning physics. A multiple representations approach to learning and teaching has the potential to produce an effective learning process. Through diverse representations will create an atmosphere of learning with the active role of all potentials of students, activating students' learning abilities, both minds-on and hands-on, so that learning is more meaningful than before. This is corroborated with the research results of Siswanto, Susantini, &Jatmiko (2016), which state that for the success of Physics learning, students need to understand the multiple representations of Physics concepts correctly and adequately. Furthermore, according to the research results of Widianingtiyas, Siswoyo, & Bakri (2015), physics learning using multiple representations has a positive influence on students' cognitive abilities because it can build students' understanding by providing complete information from various forms of representation presented. Other research results state that learning physics using multiple representations can improve student achievement and scientific consistency (Sari, Feranie, & Karim 2015).

Problem-solving develops students' ability in using the theoretical information in daily life and solving the problem they face, guiding them for studies and increasing their interest(Saribiyik, Huucekic& Yaman,2004) Ability in problem-solving is generally viewed as the ability to reason analytically, think critically and create productively which all involves quantitative, communication, manual and critical response skills. To enhance and achieve problem-solving ability, learners require a learning strategy that presents the concept fully through multiple representations (Cook 2006; de Jong et al, 2010).

Problem-solving abilities are the most important skills for a student to develop in their physics classroom. To be successful, the student must have mastered both the quantitative and qualitative skills that are a necessary part of the problem-solving process. One of the most important skills requires the student's ability to represent the problem in as many different ways as possible, which is one of the major ways that the student can show that he or she has obtained a firm conceptual understanding of the content.

The problem-solving is considered essential for understanding physics concepts and phenomena, and one of the main skills that senior secondary school physics subject is aimed to develop logical thinking structures (Jennifer, Docktor, Strand, Mestre, & Brian, 2015).Physics problem solving lends itself to the

use of multiple representations to visualize problem scenarios, relationships between quantities, and express mathematical relationships. The core 21st-century skills set out by Kay (2010) consisted of problem-solving, critical thinking, creativity, innovation, collaboration and communication. These skills are interrelated in a variety of ways, and the development of problem-solving skills especially is often tackled through problem-solving strategy.

Multiple representations can be used to address specific learning difficulty among students and to address difficult concepts in physics such projectiles, equilibrium of forces, alternating currents. Therefore, this paper is set to ameliorate specific learning difficulty among physics students and to address students' problem-solving abilities in projectiles and equilibrium of forces so it can encourage physics teachers to utilize the appropriate learning strategies.

2. Literature review

This study was guided by the constructivist approach to teaching and learning. A constructivist approach is student-centred and focuses on students' background experiences and prior learning (Duit&Confrey, 1996; Kearney &Treagust, 2001; Solomon, 2000). Learning results from experience, thinking, memory and all the other cognitive processes that build connections between new information and prior knowledge. The works of notable constructivists like Vygotsky and Bruner have direct implication for collaborative learning. This study was based on social constructivist and socio-cultural theory as the research was based on assumptions about the importance of students constructing meaning through conversation with others and the need for students to understand the multiple representations of physics concepts if they are to solve problems in physics at macroscopic, sub-microscopic and symbolic levels.

Vygotsky's research revealed that children's higher mental functions are developed by interacting with others who are more capable than them cognitively. What this means is exemplified in the following example. When a child interacts with developmentally more advanced people, for example, the more capable peers/siblings, the teacher or his/her parents, the child hears how these people see some problems and how they solve the problems. It is through interactions that the thoughts of others are revealed to the child. Through such interaction, the child has opportunities to observe others thinking and internalize the pattern of thinking. In this way, he develops new ways of thinking.

Vygotsky described this process of mental development as one that happens first interpersonally (during interaction), then intra-mentally (during internalization). He believed that this is the main way human higher mental function develops. However, he explained that for such development to occur, one key condition is that the interaction needs to be within the Zone of Proximal Development (ZPD).

A ZPD is "the distance between the actual developmental levels as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978).

One problem that teachers have is they are cognitively far more advanced than the children they teach and at times they may operate beyond the ZPD of the children. Collaborative learning provides an antidote to this situation by creating multiple ZPD (Oshima, 1998). Given that every student has a different ZPD, when they are put in a group for collaborative learning, their ZPDs overlap one another's. While the teacher's

teaching may be accessible to some more advanced students, the less advanced students can connect with the more advanced students. The overlapping ZPD of each student, when put in groups, form the multiple ZPDs which are theoretically more accessible to all the members.

2.1 Empirical Review

Many studies have been carried out on using multiple representations in problem-solving (Fredlund et al., 2012; Rosengrant, Van Heuvelen, &Etkina, 2006; Sia, Treagust, &Chandrasegaran, 2012; Tytler, Prain, Hubber, &Waldrip, 2013).Three issues developed from using multiple representations in problem-solving: how students use multiple representations when solving problems, how different representational formats affect student performance in problem-solving, and how the utilization of multiple representations learning strategies can lead to substantial improvements in problem-solving abilities. This is reinforced by the opinion Kohl and Finkelstein (2005) who examined student performance on homework problems given in four different representational formats (mathematical, pictorial, graphical, and verbal), with problem statements as close to isomorphic as possible. They found that there were statistically significant performance differences between different representations of nearly isomorphic statements of problems. They also found that allowing students to choose which representational format they use improved student performance under some circumstances and degrades it on others.

Kohl and Finkelstein (2006a) reported that students who learnt physics using lots of representations were less affected by the specific representational format of the problem. Finally, these authors investigated in more detail how student problem-solving performance varies with representation (Kohl & Finkelstein, 2006b). They discovered that student strategy often varies with representation and that students who show more strategy variation tend to perform more poorly. They also verified that student performance depends sensitively on the particular combination of representation, topic, and student prior knowledge. This is supported by the research result of Morris et al (2006) that when students are taught problem -solving strategies that emphasize the use of different representations of knowledge, they construct higher quality and more complete representations and exhibit better performance than students who are taught traditional problem-solving approaches.

Furthermore, according to the research results of Waldrip, Prain and Carolan(2010) that students benefit from multiple opportunities to explore, engage, elaborate and re-represent ongoing understandings in the same and different representations.

Ainsworth, Prain and Tytler (2011) claimed that students' explanatory drawings of aspects of phenomena could support their reasoning as well as develop their understanding of the subject-specific literacy's of science.

Ibrahim and Rebello (2012) studied the strategies engineering students employed when solving problems from kinematics and work which were represented in graphical, textual and mathematical formats and found that the representational format, prior knowledge and familiarity with the given topic influenced the students' problem-solving abilities.

There are many reasons why using multiple representations in problem-solving is conducive to an improved knowledge structure of physics concepts. Problem-solving is the principal process through which

students develop their understanding of physics concepts. It, therefore, stands to reason that using multiple representations in problem-solving will lead to physics concepts being understood better by students because, in the process of using multiple representations, students can learn meaningful and appropriate ways of representing these concepts. Furthermore, multiple representations can reduce students' cognitive load by providing an external rather than an internal representation of physical information, a process known as "distributed cognition".

More so, multiple representations provide an associated ''mental image'' of the physical processes in terms of principles and underlying concepts being considered, hence supporting comprehension. However, in many physics textbooks, multiple representations are often depicted in mathematical forms resulting in difficulty to perceive and grasp the underlying concepts or explanatory principles being highlighted by the theory under consideration and the design of multiple representations is crucial. Faulty depictions or excessive details may lead to failure in capturing the main message being communicated, hence impeding students' construction of representations and their understanding (Ibrahim& Rebello, 2013).

Also, the West African Examination Council Examiners' Reports(WAEC,2010) showed that students exhibited: poor manipulation of mathematical processes, skills in identifying, listing and labelling of some physics concepts; inadequate knowledge of basic concepts in physics (WAEC, 2010), poor skills on representing vector quantities, drawing correct labelled diagrams and poor computational skills (WAEC,2012); interpret the graphical representation of physical quantities and other diagrammatic problems (WAEC,2014,2017,2018),ineffectively handle scale drawing problems(WAEC,2015),careless in symbol identification and inability to interpret statements in workable diagrams(WAEC,2013,2018)and inability to plot graphs correctly(WAEC,2008,2017).

Many studies were also geared towards exploring the application of multiple representations for conceptual understanding (Van Heuvelen& Maloney, 1999) and enhancing problem-solving performance (Dufresne,Gerace& Leonard,1997). Also, studies have looked into the possible factors leading to the ineffectiveness of teaching and learning based on multiple representations.

Kohl, Rosengrant and Finkelstein (2007) reported that students' inability to relate and translate information within and across representations was found to be the main inhibitor to comprehension, in the learning process and improved problem-solving performance. It wasalso reported that although instructional strategies were designed to teach students to make connections within and across representations, they were not always successful (Rosengrant, Van Heuvelen&Etkina, 2006; Seufert, 2003)

Many elements come into play when dealing with multiple representations. These include the students' meta representational skills, representational competence, representational fluency, representation preference and representations format.

Nurrahmawati, Cholis Sa'dijah, Sudirman and MakbulMuksar (2019) explored the ability of multiple representations of college mathematics education students to solve word problems and what representation forms are used. It was found that multiple representations' ability of students in solving problems was influenced by individual characteristics and the learning experience that they get before.

Huda, Siswanto, Kurniawan and Nuroso (2016) used a learning tool based on multi-representations to improve problem-solving skills. They used the development approach and course of Fundamental Physics

at Universitas PGRI Semarang for the 2014/2015 academic year. The result of the finding showed that multi-representation learning tools significantly improved students' problem-solving abilities.

Maries (2014) affirmed that when students used different representations, they become better problem solvers. More specifically, when they learn to solve problems through the use of multiple representations, they can perform better compared to the students who traditionally learn problem-solving strategies, similarly, DeLeone and Gire (2005) explained that the use of multiple representations in physics becomes more important since it is connected to students' problem-solving ability. Moreover, in addition to students' prior knowledge as well as the subject taught, Kohl and Finkelstein(2006b)researched that the use of multiple representations in learning enhances students' understanding of science (physics).This implied that to become better problem solvers in physics, multiple representations learning strategy is the main processes that students need to develop an understanding of physics. This corroborates the finding of Van Heuvelen& Zou (2001) who found that multiple representations learning strategies were more effective than traditional instruction. Multiple representations learning strategy is very useful in physics education especially in developing the students' understanding of physics problem, building a bridge between the verbal representation and mathematics, and helping the students to develop an idea that gives meaning to the mathematical symbol.

Kohl and Finkelstein (2017) presented a series of empirical studies on undergraduate students' use of representation in introductory physics to describe when and how students use representations and to understand the impacts of varied instructional strategies on student performance with representations. The results of the findings showed that student performance on isomorphic problems varies, depending on the representational format used.

3. Hypotheses

The following null hypotheses were tested at 0.05 level of significance

H_{O1} :There is no significant difference in the problem-solving abilities of students taught using multiple representations learning strategies and those taught using conventional strategy

H_{O2}: There is no significant interaction effect of treatment and gender on problem-solving abilities of senior secondary school physics students.

H_{O3}: There is no significant interaction effect of ability level and gender on problem-solving abilities of senior secondary school physics students.

4. Methodology

This sudy adopted a 3-group, pre-test, post-test and control group quasi-experimental design. To study the effect of each factor on the response variable, as well as the effects of interactions between factors-, a 3×2×3 factorial design was adopted in this study.

The experimental groups were diagrammatically illustrated below:

O_1 X_1 O_2 = Treatment Group 1(Multiple Representations Learning Strategy)

O_3 X_2 O_4 = Treatment Group 2 (Problem-Solving Learning Strategy)

O_5 O_6 = Control Group (Convectional)

Diagrammatic representation of the research design,
where:

$O_{1,3,5}$= Pre-test observation

$O_{2,4,6}$= Post-test observation

X_1 = Treatment one (Multiple Representations Learning Strategy)

X_2 = Treatment two (Problem –Solving Learning Strategy)

= Control Group (Conventional Strategy)

The ground method employed for the two learning strategies was collaborative learning. In other words, these strategies were combined with collaborative learning. Table.1shows the two experimental groups E1, E2 and one control group, C.

Table 1: Summary of the Research Design Employed in the Study

Groups	Pre test	Multiple representations learning strategy	Problem-solving learning strategy	Conventional method	Post test
Experimental group 1 (E_1)	*	*			*
Experimental group II (E_2)	*		*		*
Control group (C)	*			*	*

* = Treatment

4.1Treatment procedure

Pre-activity instruction

Treatment group I

- The teacher stated the learning objectives of the contents to be learnt by students
- The teacher informed students that they are going to learn the concepts using multiple representations learning strategies.
- The teacher informed students that they were expected to work in groups, solve problems and show their solution on cardboard

Activity tasks in class:

- Teacher guided students informing groups of eight students per group
- Teacher ensured that each group consists of mixed ability.
- Each group was instructed to choose a group leader
- Each group is directed to develop plans on how to involve all the members in the group in constructing representations.
- Learning materials and other relevant resources were distributed to students

- The teacher presents ideas visually on the chalkboard
- The teacher talks and writes notes on the board while students are writing notes
- Teacher and students interacting as a whole class during the lesson
- Students in small group discussion
- The teacher engages students in class activities constructing representations (i.e. verbal, diagram, symbol and mathematical)
- Each group interacts and proceeds to solve the problem on their own as follows
  - (a) Students construct representations to clarify the problem
  - (b) Students translate the words into the symbolic language of physics
  - (c) Students use specific physics representations to construct a mathematical equation Students use the equation to solve the problem.

Treatment Group 2

Activity tasks in class:

- Teacher guided students in forming groups of eight students per group
- The teacher ensures that each group consists of mixed ability.
- Each group was instructed to choose a group leader
- Each group is directed to develop plans on how to involve all the members in the group in constructing representations.
- Learning materials and other relevant resources were distributed to students
- The teacher presents ideas visually on the chalkboard
- The teacher talks and writes notes on the board while students are writing notes
- Teacher and students interacting as a whole class during the lesson
- Students in small group discussion
- Each group interacts and proceeds to solve the problem on their own as follows
  - a) Students construct an informative diagram of the physical situation
  - b) Students identify and list the given information in variable form
  - c) Students identify the unknown information in variable form.
  - d) Students identify and list the equation that will determine unknown from known information
  - e) Students substitute known values into the equation and use appropriate algebraic steps to solve for the unknown information
  - f) Students check answer if it was reasonable and mathematically correct.

4.2 Validity and Reliability of instruments

The instruments were given to two SSII physics teachers, who had over ten years teaching experience and two science education experts in physics and experts who were knowledgeable in test construction subjected these items to scrutiny and content validation. The items were moderated and the language used was modified to suit that of SSS II students. As a result of the corrections, some of the items were restructured while some were added. Thereafter, the instrument was administered to randomly selected SS2 students from schools that were not part of the sample to ensure that the questions raised are not beyond the

understanding of the students. Multiple Representations Assessment Instrument (MRAI), Problem –Solving Assessment Instrument (PSAI), Knowledge of Multiple Representations in Projectile and Equilibrium of forces (TKMRA-PE test were determined using the SPSS version 23 on the responses of the sample and the split-half reliability coefficient computed value were found to be 0.75, 0.70 and 0.85 respectively and these values were considered adequate for using these instruments.

5. Results

H_{O1}: There is no significant difference in the problem-solving abilities of students taught using multiple representations learning strategies and those taught using conventional strategy

Table 1 revealed that there was a significant difference in the problem-solving abilities of students taught using multiple representations learning strategies and those taught using control; $F(2,291) = 4.440$; $p < 0.05$, $\eta^2 = 0.030$. Therefore, hypothesis H_{O1} is rejected. Table 4 presented that those students exposed to multiple representations learning strategy had the highest problem-solving abilities mean score (38.32) followed by the students exposed to problem-solving learning strategy (29.48) while those exposed to control group had the least mean score (22.38).Table 5 presented Bonferroni analysis to determine the source of the observed significant difference. The table 4 showed that the multiple representations learning strategy performed significantly better than all the two other strategies. It was also revealed that there was a significant difference between the experimental group 1 and control groups. There was a difference in the mean score experimental group 1 and experimental group 2, but it was not significant.

Table 1 Summary of Analysis of Covariance on problem-solving abilities

Dependent Variable: Posttest TKMRA-PE

Source	SS	df	MS	F	p	η
Corrected Model	22495.425[a]	3	7498.475	36.398	.000	.274
Intercept	42472.830	1	42472.830	206.167	.000	.416
Pre-KMRA-PE	9162.908	1	9162.908	44.478	.000	.133
Treatment	1829.499	2	914.749	4.440	.013	.030
Error	59743.310	290	206.011			
Total	354818.000	294				
Corrected Total	82238.735	293				

a. R Squared = .274 (Adjusted R Squared = .266)

Table 2 Summary of 2-ways Analysis of Covariance on problem-solving abilities

Source	SS	Df	MS	F	p	η
Corrected Model	21822.099a	3	7274.033	34.915	.000	.265
Intercept	40571.291	1	40571.291	194.742	.000	.402
Gender * Treatment	21822.099	3	7274.033	34.915	.000	.265
Error	60416.636	290	208.333			
Total	354818.000	294				
Corrected Total	82238.735	293				

R Squared = .265 (Adjusted R Squared = .258)

Table 3 Summary of 2-ways Analysis of Covariance on problem-solving abilities
Dependent Variable: TKMRA-M

Source	SS	Df	MS	F	p	η
Corrected Model	22187.292a	6	3697.882	17.673	. 000	.270
Intercept	40892.007	1	40892.007	195.433	.000	.405
Ability level * Treatment	20173.812	3	6724.604	32.138	.000	.251
Error	60051.442	287	209.238			
Total	354818.000	294				
Corrected Total	82238.735	293				

a. R Squared = .270 (Adjusted R Squared = .255)

Table 4 Descriptive statistics on the treatment and problem-solving abilities scores

Learning strategy	N =294	
	Mean	SD
MRLS	38.3153	14.19154
PSLS	29.4824	22.15992
CS	22.3776	7.53208

Table 5: Summary of Bonferroni analysis of problem-solving abilities

Treatment	Control	Experimental I	Experimental II
Control		*	*
Experimental I	*		
Experimental II	*		

Table 2 revealed that there was significant interaction effect of treatment and gender on problem-solving abilities of senior secondary school physics students; $F(3,290) = 34.915$, $p < 0.05$,partial eta $\eta^2 = .265$. Therefore, H_{O2} is rejected.

Table 3 revealed that there was significant interaction effect of treatment and ability level on problem-solving abilities of senior secondary school physics students; $F(3,287) = 32.138$, $p < 0.05$, partial $\eta^2 = .251$.Therefore,H_{O3} is rejected.

6. Discussion of findings

The main focus of this study was to determine whether or not there would be any significant difference in knowledge of students exposed to the use of multiple representations learning strategy and problem-solving learning strategy and those in the conventional strategy. This study revealed that there was relative effectiveness in the effect of multiple representations learning strategies and problem-solving learning strategy and conventional method on problem-solving abilities of senior secondary school students in physics. Besides, students in experimental group 1 (multiple representations learning strategy group) had the highest mean score while the lowest mean was observed in the conventional method group in problem-solving abilities (Table 4). This shows that multiple representations learning strategy enhanced greater problem –solving abilities in students while the conventional method was the least. This finding was in line with other studies such as Adadan,Trundle&Irving, 2010; Aspinwall& Miller, 2001;Etkina, Rosengrant, & Van Heuvelen, 2008; Nyman, 2003; Berry&Hilton and Nichols, 2011, Wu& Puntambekar, 2012).These studies reported that students taught using multiple representations learning strategy resulted in growth in student understanding of physics concepts, increased ability in physics problem solving, and correct use of multiple representations in physics problem-solving. This was also corroborated in this study as it was found that students in the experimental group I (multiple representations learning strategy) performed better (mean = 38.32) than their counterparts in the (experimental group II) problem-solving learning strategy group with a mean score of 29.48 and the control group with the least mean of 22.38. Furthermore, it was also found that a significant difference exists among the problem-solving abilities mean scores of students exposed to multiple representations learning, problem-solving learning strategy and conventional method; multiple representations learning strategy and problem-solving learning strategy (Table 1). This is because the students were able to translate verbal problems to the appropriate visual, formulae and numerical solutions. This remarkable result could be as a result of the effectiveness of the intervention on the problem-solving abilities of physics students. Also, students learnt how to represent a physical situation in concert with physics concepts through diagrammatic representations and their

agreement with other types of representations (verbal, symbolic and numerical) which enables them to develop mathematical solutions from problems that start in verbal and diagrammatic representation. This was in agreement with the findings of Finkelstein, Adam, Keller, Kohl, Perknis, Podolefsky&Reid(2005); diSersa&Sherin(2000);Finkelsteinetal(2005);VanHenvelen(1991a,1991b,2001) and Waldrip&Prain(2004) who found that multiple representations learning strategy help students to master physics concept and use them for successful problem-solving. In this study, a significant two-way interaction effect between teaching strategy and gender was found on problem-solving abilities in physics (Table 2). This means gender is dependent on the interaction effect of the teaching strategies to affect better problem-solving abilities.

This means gender is dependent on the interaction effect of the teaching strategies to affect better problem-solving abilities. The implication is that only the joint effect of strategy and gender could affect problem-solving abilities of senior secondary school physics students. This is so because the teaching strategies used in this study allowed students to interact with the tasks given irrespective of the sex and allow them to redefine their learning. The students were able to attain their personal goals by encouraging others within their group to do whatever will help the group to succeed. In other words, when students interact with each other's, they have to explain and discuss each other's perspectives which may lead to a greater understanding of problems solved. Therefore the students can be said to have constructed their learning by themselves instead of knowledge transmitted directly from the teacher to the learner. Teachers should therefore note that mixed gender group and teaching strategies with the appropriate learning activities will not only make students active learner, and make them restructure and construct their knowledge but improve their ability to build and transforming knowledge.

The study further found a significant two-way interaction effect of the strategy of learning and ability levels on problem-solving abilities when students are taught physics using multiple representations learning strategy and problem-solving learning strategy as presented in Tables 3.This shows that ability levels and strategy of learning jointly enhance problem-solving abilities of physics students. In other words, each of the variables depends on each other for effective and meaningful learning to take place. Therefore, problem-solving abilities could not be completely attributed to either the effect of a strategy of learning or ability level; rather it is a joint effect of both ability level and strategy of learning. This finding is in line with Adeyemo (2010) who carried out an investigation on students' ability level and their competence in a problem-solving task in physics and found out that students' ability has a significant influence on a problem-solving task. It can be concluded that problem-solving abilities among physics students are ascribed to both the effect of gender and ability level. Therefore, students' ability levels in this study could be considered in a mixed-gender physics classroom for better enhancement in problem-solving abilities. This finding is in disagreement with the work of Herrmann and Crowford (2008) when examining high school students complete various scientific tasks; found that males out performed females in interpreting results. However, the result agrees with Agomuoh, (2010) who mentioned that males and females are the same if they are treated under the same condition but, not in line with the study of Fatoba and Aladejana (2014) on gender. They found a slight difference in students' attitude in favour of females in Physics. This disagreement could be accounted for by the fact that the concepts investigated differ and the classroom settings are not the same. It may also be that the sample size and the sampling techniques differ.

7. Implication of findings

The findings of this study had shown that effective physics instruction needs more than talk and chalk approach. It requires the active involvement of the students in the physics learning process. Multiple representations learning strategy meet this need in a physics classroom. Also, in helping students develop representational ability, physics teachers must provide students with multiple opportunities to create representations on their own, similar to the writing-to-learn activities described in the work of McDermott and Hand (2012) and others (Hand et al., 2009; McDermott,2009).

The results have implications on the current trend of test development adopted by the public examining bodies in Nigeria and indeed in most countries in West Africa. This is because the West African Examinations Council conducts examinations (WAEC) for the Anglophone countries in West Africa. The current items generated for physics test items are lacking connections among representational modes of physics concepts. Almost all physics questions in WAEC and NECO exams only served to include the symbolic and diagrammatical modes of representations. More so, WAEC and NECO should endeavour to set test-items that determine the level of problem-solving abilities rather the level of knowledge the candidates can acquire

Conclusion

Multiple representations learning strategy is effective in helping learners to visualize physics concepts hence resulting in a higher level of conceptual understanding and problem-solving ability.

The problem-solving learning strategy has been found to develop students' ability in using theoretical information in daily life and solving the problems they face, guiding them to study and increasing learners' interest.

Therefore, teaching strategies that emphasis on activity-based learning which is an effective strategy of teaching and development of skills required of physics students towards learning for understanding should be adopted as modes of learning to replace the conventional method which dominates our secondary school classes. This, of course, may further solve the problem of large classes, inadequate instructional materials and make peers complement the teacher who cannot afford to attend to students one by one because of an over load of teaching and administrative duties**.**

Recommendations

Based on the findings of this study, the following recommendations were made:

1. Physics teachers should consider using multiple representations learning strategy to teach physics concepts especially difficult concepts. This strategy is student's centered and efficacious in raising achievement and problem-solving abilities which would avail the students the opportunity of constructing learning in their way thereby enhancing problem-solving abilities in physics.
2. Teachers should be mindful of the fact that different ability students are in their class and therefore vary teaching strategies to accommodate the differences in the ability of students is essential. In other words, incorporating activity-based approaches such multiple representations

teaching-learning situation could encourage and enhance problem-solving abilities since this would allow the students to learn from each other.

3. This study has shown that when students are taught with an interactive, innovative strategy such as multiple representations learning strategy the problem-solving abilities increases. It is also revealed that interaction between ability level and learning strategy improves the problem-solving abilities of physics students, therefore; learning strategy that takes into consideration the different ability levels should be employed in physics classes to enhance the problem-solving abilities of students.
4. Physics students should be taught how to represent concepts in multiple ways such as a verbal, diagram, symbolic and mathematically as a means of enhancing their problem-solving abilities in the subject.

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