

Learning as a permanent innovation: advances on studies of the intellect

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Abstract

Even though research shows that incorporating metacognition-based pedagogy into the classroom leads to improved student performance, educators' grasp of the concept remains limited. It is argued that educators would benefit from a deeper familiarity with the metacognitive approach if they worked with students to foster a belief that education has the potential to inspire a lifelong curiosity for discovery and improvement. This article therefore provides a synthesis of the analysis of the outcomes of implementing metacognition-based pedagogical approaches (N = 83), published between 2016 and 2021. Researchers looked into teachers' conceptualizations and implementations of pedagogical strategies in order to comprehend the factors that stimulate students' perceptions of innovation. From these studies, we can infer that the learner experiences, perceives, and comprehends the new information as an integral part of himself, rather than as an imposition from without. The findings led to the presentation of five hypotheses about how educators can improve their practice by learning more about students' perceptions, cognitive experiments, and interpsychic and intrapsychic social relations.

Keywords: Teaching methodology. Conception of learning. Cognition. Theory of Mind. Metacognition.

1. Introduction

The disciplines of psychology of learning and cognitive psychology have both historically devoted considerable resources to the study of learning. A lot of others argue that the epistemological foundations of learning are passed on in various ways, including through psychogenesis, social learning, and the reflective act of the learners themselves (MIZUKAMI, 1986; PISTÓIA, 2009; STERNBERG, 1976, 2018; STERNBERG; STERNBERG, 2017; VEIGA, 2011; VEIGA; D'ÁVILA, 2014; VYGOTSKY, 2001). The paradigms of psychogenesis (PIAGET, 1977), historical-critical learning (DAVYDOV; ZINCHENKO, 1981), and reflection in action (SCHÖN, 1983) are all relevant to this discussion because they provide a theoretical framework for understanding how the learner subject can view its own metacognitive processes as a form of ongoing self-invention. The term "innovation" is used from these vantage points to highlight the connection between the subject's lifelong accumulation of knowledge and what is currently unknown.

Not all authors see innovation as the introduction of anything novel; some describe it instead as the

utilization of a previously existing method (GOVINDARAJAN; TRIMBLE, 1994). For others, the term refers to the introduction of a novel thought or concept (SCHUMPETER, 1997).

Others have drawn comparisons to the paradigms of disruptive innovation, which proposes a completely novel product that is unlike anything else on the market; incremental innovation, which permits slow but steady improvements with minimal risk; and radical innovation, which proposes to explore completely novel aspects of an existing product (BIRNBAUM; CHRISTENSEN; RAYNOR, 2013; BRESSANT; TIDD, 2019). The authors also divert attention from innovation itself to its byproducts—namely, new products, services, and uses—as well as the disruption of long-standing ideas (BIRNBAUM; CHRISTENSEN; RAYNOR, 2013; SCHUMPETER, 1997). We do find a link between creativity and learning, but we don't look at it in terms of the outside world. Instead, we look at the internal processes and motivations of the people in this study.

We examine the inner workings of innovation by looking at how it is taught in Finnish classrooms and how it uses imagination to address challenges. Such an implementation hints at the possibility of a deep and integrated pedagogy that pushes students to not only try out different perspectives and strategies for accomplishing their goals, but also to reflect on and adjust their own methods as they go along.

As a form of education, the development and implementation of an innovation involves a wide range of interrelated activities. When individuals are unhappy with something or want to do something differently than they have in the past, this creates a need to change the praxis (LINDFORS; HILMOLA, 2016, p. 377).

This introspective approach to invention shares certain characteristics with the "maker" mindset. Innovation here means fostering creative thinking so that fresh methods can be devised to address critical concerns. Academic studies in the United States have investigated this direction, with positive results for the teaching of reverse innovation.

Universities are taking notice of the growing popularity of makerspaces and community events like Maker Faires and hackathons as a means to foster interdisciplinary teamwork, creative problem solving, and entrepreneurial innovation. Some of the world's most intractable challenges span the fields of science, engineering, the arts, design, psychology, and more, and universities are beginning to recognize the value of bringing students from these many backgrounds together to tackle them. Having students from different majors work together has many positive effects on the university as a whole. Students can learn from each other's experiences, come up with creative solutions to problems that wouldn't occur to them in their own field, and form new, productive partnerships within the academic community (HYNES; HYNES, 2018, p. 868).

Students' use of software that gives them access to self-assessment activities has been studied to better understand the role that students' own evaluations of their own performance may have as a catalyst for improvement.

Although we did not have students evaluate their own performance against predetermined standards, we do think the self-evaluation activities we created can serve as a foundation for future student evaluations of their own performance (IBABE; JAUREGIZAR, 2010, p. 255).

The proposed concept of innovation does not center on things that do not currently exist in the world outside of the individual, as shown by the arguments presented. We assume that a learner's adoption of a fresh vantage point, values, and approaches to perceiving and responding to the environment is at the heart of all

meaningful innovation in the field. In contrast to Christensen's disruptive innovation theory, this method focuses not on how much education costs but on how well a student's hidden potential is evaluated.

In order to examine and analyze the expressions of perception and emotion in the individual when learning, we here use a contemporary perspective on the study of the human mind connected to theories of mind, metacognition, and cognition, as evidenced by cognitive psychology (CANDEIRA, 2017; STERNBERG, 2018; STERNBERG; STERNBERG, 2017; ZORTEA; JOU; SALLES, 2014a, 2014b). This theory says that humans have a level of consciousness called metacognition. Metacognition is the ability to think about what you know and how other people see the world so that you can make smart decisions about it.

From a theoretical examination of articles drawn from the consulted databases, we predict that a learner's awareness of what he or she does not yet know can give rise to the impression that learning is imminently attainable. If they know how they feel, it might make them think about how their views on their activities are changing as they learn and take in new information.

We propose that Vygotsky's concept of the Zone of Proximal Development (DANIELS; COLE; WERTSCH, 2007) provides a helpful framework for considering the learner's experience of learning, both in terms of the learner's interpretation of his or her own cognition and as a potential agent of change in his or her social environment. In this article, we adopt the viewpoint of psychogenesis, which is predicated on the concept that learning results in innovation anytime anything new is shaped in the mind of an individual.

2. Materials and Methods

2.1 Innovation and human curiosity

Let us compare and contrast two prevailing models of innovation. The first type, which we'll call "external to the individual" or "extrinsic," is characterized by the subject's reading of the world around them as merely a need for information consumption, survival, or, in some cases, meeting the need to situate themselves in their social reality, looking to increase their sense of comfort and security. Here, we talk about a second model of the idea of innovation, which we call "intrinsic." In this model, the subject's own thoughts are always guided by the subject's own desire to know, not necessarily to learn, but mostly to be informed.

When talking about the first paradigm, which views innovation as something external, we need to keep in mind two primary factors. The first line of thought contends that "[...] are continuously added to the existing stock of knowledge" when people follow their curiosities, which in turn helps them find solutions to their economic problems (SCHUMPETER, 1997, p. 82). Because an individual's experience—both personal and observed in others' lives—gives him or her confidence in the stability of the ground upon which he or she walks, it's plausible to link the concept of stock of knowledge with a continuous and recursive action (SCHUMPETER, 1997, p. 83). The concepts of product, process, position, and paradigm are the focal points of the second line of "extrinsic" innovation. In this sense, invention is crucial to "[...] our survival and our growth" as a species. An individual's instinct and survival instinct are strongly linked to the innovation process because "[...] lifestyle is constantly shaped and remolded by the innovation process" (BRESSANT; TIDD, 2019, p. 5). A common understanding between these two schools of thought is that innovation is "[...] what has not yet been done." (LAZZAROTTI; DALFOVO; HOFFMANN, 2010, p. 4).

At this point, it has been stated that innovation, even if it is not intrinsic to the subject, is motivated by the desire to survive, which is assured by an economic balance and is a priori based on the accumulation of a store of knowledge. That is to say, the subject will initially pursue innovation out of a biological necessity for survival and only later out of pure curiosity. This highlights the need to provide background for understanding the link between economic survival and curiosity. The theory put forth by the Austrian school of economics will be defended here as a means to this objective. This school of thought believes that economic law should focus on the analysis of logical concepts and implications in individuals' preferences and decisions (MISES, 2013). In tandem with this is the field of praxeology, which holds that all human action is motivated by a desire to maximize or minimize one's own subjective well-being according to a hierarchy of demands that is not always objective or rational (CATHARINO, 2013). In this view, the individual is motivated to acquire information by a desire to address his or her own unique set of requirements, needs that are both deeply personal and directly relevant to the pursuit of his or her current interests.

From this, we can infer that (a) the individual will seek out information about what makes him or her feel better and more secure, and (b) the individual's social environment will adapt to meet the needs recognized by the individual, with the individual's interests in mind. To avoid confusion with the concept of andragogy (KNOWLES; III; SWANSON, 2009), we emphasize that the inferences made here point directly to premises internal to the individual rather than to external factors like the reason for learning, the learner's autonomy during the learning process, the learner's experience, the context related to the learner's practical life, the problematizing context of the learner, and the "intrinsic" reward value. These principles are connected to the belief that one's internal motivation should come first, before any external motivator or possible reward, and that impending learning has the ability to transform whoever one already is.

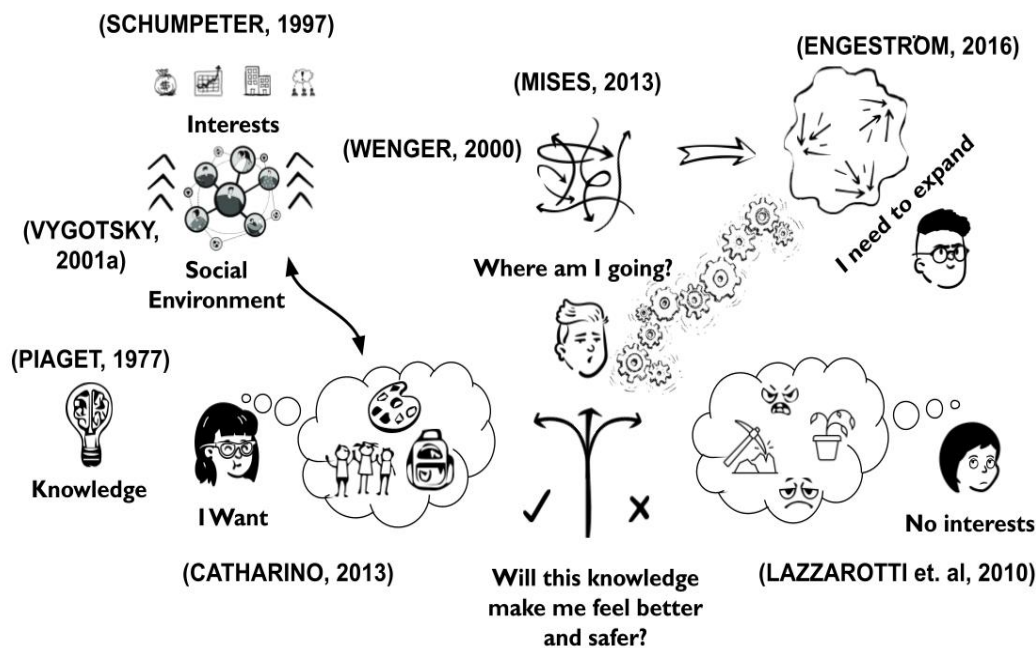


Figure 1 - How the individual selects his/her interest for the gain provided by knowledge and the social environment in this setting, with reference authors.

Authors inferred (2022).

Error! Reference source not found. shows what influences a subject's perception: the social environment (VYGOTSKY, 2012). In a psychogenetically mediated process, the mind strives to generate meaning to better understand the world (PIAGET, 1977). According to the Austrian school of economics, human behaviour is driven by primal biological desires. The vision of social meaning negotiation points in different ways (WENGER, 2000). Need-driven learning (CATHARINO, 2013). Self-expansion leads to higher heights, revealing the mind's perception (ENGESTRÖM, 2014). The exclusionary approach shows that external stimuli, no matter how thrilling, do not always promote transformation (LAZZAROTTI; DALFOVO; HOFFMANN, 2010).

2.2 Reflecting on the psychogenesis of perception

According to the research, one's level of perception is a key determinant in their educational success. Children between the ages of seven and eleven were tested on their capacity to sketch a representation of an object based on the shadows cast by that object, and the results showed that beginning at age eleven, the children began to demonstrate a rather high degree of accuracy. However, this relationship is reversed, such that the accuracy of the representation diminishes as age grows, when only close items are considered in response to perception of the same object at a distance and not their reproduction using drawings.

At the operatory level, when he begins to construct and generalize the systems of reference (by generalizing two- and three-dimensional measurement), the habits that he acquires orient his perceptual exploration and, therefore, indirectly modify the child's perceptions (PIAGET, 1977, p. 22).

In light of recent perceptual studies, we can consider that a "[...] hermeneutic circle of knowledge in action is generated, as it articulates practice and theory, stimulating new theories and new practices" in social learning encounters, wherein new practices are born (PANASIEWICZ, 2020, p. 190). We can suppose that perception controls education in this hermeneutic loop.

As constants, these connections could be factored out and ignored in the study of the individual functions; for example, perception was assumed to always be connected in the same way to attention, memory to perception, and thought to memory. The evolution of consciousness was thought to be determined by the independent growth of the individual functions since the relations remained irrelevant (VYGOTSKY, 2012, p. 2 [1986]).

This line of inquiry, however, reveals that changes in the psychic sphere share the same basic make-up as those that occur in the brain's multi-faceted structure of consciousness (perception). Therefore, the connections between seeing, paying attention, remembering, and thinking, as well as the consequent nuances in development, should be the primary focus of cognitive psychology. Instead of making broad assumptions about the relationships between these functions, he argues that specific research into them is required. In order to make progress in the study of language and cognition, it is necessary to adopt this shift in perspective.

When we use a term, we're not referring to a specific thing, but rather to something more general, like a category. So, every phrase is already an oversimplification. In generalizations, truth is reflected in generalizations in a way that is very different from the way it is reflected in sense and perception, because generalization is a linguistic act of thought. The claim that there is a dialectical leap between the state of

complete unconsciousness (in inanimate matter) and the experience of sensation, as well as between sensation and thought, implies this kind of qualitative difference. A broad reflection of reality, which is also the essence of word meaning, separates thought from experience, and hence, meaning is an act of thought in the full sense of the term. While meaning does reside in the world of mind, it is also an inherent part of words as such and thus has a place in the sphere of language as well. A word deprived of its original meaning becomes a meaningless utterance. The unit of verbal thought we seek, the word meaning, combines cognition and speech. Therefore, semantic analysis—the study of the formation, operation, and structure of this unit, which includes connected thought and speech (VYGOTSKY, 2012, pp. 6–7 [1986])—is the approach to take in our investigation of the nature of verbal thought.

From this, we can infer that Vygotsky's conception of representational perception of the world mobilizes operative cognitive functions, which, according to Piaget, are already present in children and will mature in adults, resulting in a social reading of the world and an increasingly complex representation of it.

Learning as an individual's permanent invention is supported by research in the fields of psychogenesis (PIAGET, 1977), social historical-critical learning theory (DAVYDOV; ZINCHENKO, 1981), and the view of the reflex act (SCHÖN, 2000). Recent research provides a reading from the standpoint of cognitive psychology, which links the three theories described below (social practice in (WENGER, 2000), social interaction in Leontiev (LEONTIEV, 1981), and experience result in (ENGESTRÖM, 2015)) from their respective vantage points.

2.2 Three contemporary theories of learning

In the following, we'll examine three theoretical viewpoints and how they relate to the previous classical works.

2.2.1 Wenger and cognition as social practice

(WENGER, 2000), writing about communities of practice, argues that the act of doing something, and doing it again, both contribute to the subject's learning by providing a means by which the subject can periodically and systematically examine what it has learnt. The method and its outcomes will benefit from this change. It is reasonable to assume that the sharing of meanings, the learning itself, and the limits related to it are found in the social practice that involves learning, as suggested by (WENGER, 1998), since the acquisition of knowledge involves the learning subject's perception of himself, of the colleagues with whom he shares his practice, and of the situations that require a response from himself.

Education, in its deepest sense and at whatever age it takes place, concerns the opening of identities — investigating new ways of being that lie beyond our current situation, as outlined by Wenger. The goal of education should be to open up new horizons for the negotiation of one's own identity, whereas the goal of training should be to build an inbound trajectory aimed at proficiency in a particular skill. In doing so, it sets students on a path outward toward a wide variety of possible selves. Education has a transforming effect rather than only a formative one (WENGER, 1998, p. 263).

Wenger argues that a critical factor in the development of practice-oriented trajectories is the fact that

they need not take into account the individual's chronological age. In this light, he emphasizes the need for learning by doing rather than relying on step memorization.

Reifying learning as a process and its participants as learners can be counterproductive if the focus is solely on the mechanics of learning at the expense of meaning. For example, it's much more challenging to learn a new term if you're just going to memorize a list of them instead of using them in context (WENGER, 1998, p. 266).

Therefore, Wenger's theory of learning emphasizes the importance of practice as a means of stimulating, constructing, and prodding cognition, but always with social interaction. The term "interpsychic function" is used by (LURIA; LEONTIEV; VYGOTSKY, 2007) to describe this phenomenon, which we will show to exist.

2.2.2 Leontiev and social interaction as a determinant of learning

They developed the social-historical theory of the emergence of higher psychic functions, also known as particularly human functions (LURIA; LEONTIEV; VYGOTSKY, 2007). As a reaction to behaviorism and the emphasis on the stimulus-response mechanism, his "psychointelective" study emphasizes the importance of social contact throughout the learning process.

While acknowledging the development of children's higher-order cognitive abilities as a phenomenon without parallel in human history, Leontiev went on to argue that all of these abilities manifest themselves twice in a child's life: once in the group activities carried out during social interactions (as an interpsychic function arising from the shared experience of two or more people) and once in the individual activities (arising from the private experience of one person).

According to Leontiev, the evolution of languages is illustrative of this point. To him, a child's first language serves as a means of interaction with the people around him. When the language is internalized, it becomes a mental function and the child's primary source of thought. Piaget's studies, emphasized by Leontiev and others, reveal that children's curiosity about how others think is sparked by their own conversations. The child doesn't start to think as an internal activity whose defining feature is knowing and verifying the basics of his or her own concept until much later. In addition, Leontiev agreed with Piaget that it is only via speech that the opportunity to check and validate one's own thinking arises (LURIA; LEONTIEV; VYGOTSKY, 2007, pp. 35–36).

Interpsychic functions (the preexisting social relations) and intrapsychic functions permeate all of Leontiev, Luria, and Vygotsky's theories (the autonomous thought itself). Specifically, we focus on the following passage. All higher psychological functions manifest themselves twice during a child's development: once in group or social activities, or "interpsychic functions," and once in individual activities, or "intrapsychic functions," as internal aspects of the child's mind (LURIA; LEONTIEV; VYGOTSKY, 2007, p. 36).

Reasonable inferences can be drawn about the interconnectedness of these functions, which feed off each other through the activity established in each movement in the context of the interaction between the subject's internal and external environments. Activity in the interpsychic domain is determined by the social relationship established through conversation, the interchange of glances and gestures, and the performance of acts directed at and received from other members of the group. As a result, Leontiev concludes that "[the] thousands of

years of social history have done much more in this respect than the hundreds of millions of years of animals' biological evolution." As noted by Leontiev (1981, p. 132).

By interacting with others, man is able to reshape his behavior; by learning from the actions of others through the use of cues, he is able to take control of his own actions; processes that were once interpsychological, such as imitation, are transformed into those that occur within the individual's mind. Although this connection becomes more clear during the process of learning to speak, it is just as valid for other mental operations. It's also what makes up the evolutionary trajectory of more complex types of memory; as we've seen, the memory of modern man isn't some simple, innate trait, but rather the incredibly nuanced end result of eons of historical accumulation (LEONTIEV, 1981, p. 363).

Thought, on the other hand, is the driving force behind action in the intrapsychic function, where it fully mobilizes mental resources for the purposes of synthesis, invention, deduction, conjecture, and observation. This kind of action gets a person right up to the threshold of being able to perceive their own thoughts.

2.2.3 Engeström and experiential consequential learning

Engeström analyzes Piaget's cognitivism, the historical-social strand of Russian school theorists like Vygotsky, Leontiev, Luria, Zinchenko, and Davydov; historical materialism with Marx, Hegel, and Ilyenkov; Popper's critical rationalism; Peirce's semiotics; Mead's interactionism; and Dewey's pragmatism, showing how human activity structure affects social interaction. Figure 2 shows the origin of Vygotsky's mediated act structure.

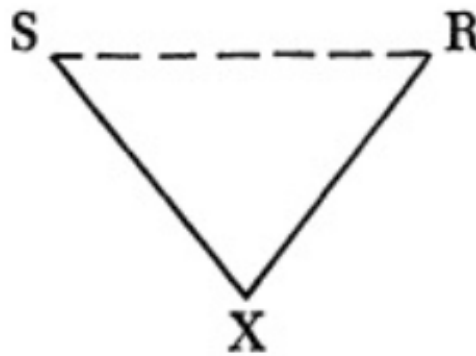


Figure 2 - Structure of the mediated act.

Source: (VYGOTSKY, 1978, p. 46).

Every basic form of activity requires a direct response to the organism's task ($S \rightarrow R$). Sign operations require a relationship between stimuli and response. This intermediate link is a second-order stimulus (sign) that is inserted into the procedure to build a new relationship between S and R and "drawn into" means a person must deliberately create a link. This sign operates on the individual, not the surroundings (VYGOTSKY, 1978, p. 46).

Engeström believes that Vygotsky's representation shows an organization that he believes is basic in all higher psychological processes ($S \rightarrow R$). Vygotsky says there is always an auxiliary stimulus X in the chain between stimulus and response, whose job is to bring the person to a specific behavior pattern that breaks with

biological development, generating a culturally based psychological process. Vygotsky calls this "Signs Operations" and notes that a person must be actively involved in developing a mediated relationship (VYGOTSKY, 1978, p. 45). By requiring the individual's attention, something vital is presented: "The sign also possesses the important characteristic of reverse action (that is, it operates on the individual, not the environment." (VYGOTSKY, 1978, p. 46).

Engeström expands Leontiev's (1981) activity theory with interpsychic and intrapsychic functions to the social environment. Engeström says they evolve "naturally" like animals to humans. By studying Marx's production mode and historical materialism, Engeström places these relations in the chain of social interdependence of production based on production, distribution, and exchange (or communication). This enables analyzing the activity's structure in numerous ways, as well as looking at the whole in a systemic and interconnected approach, as shown in Figure 3.

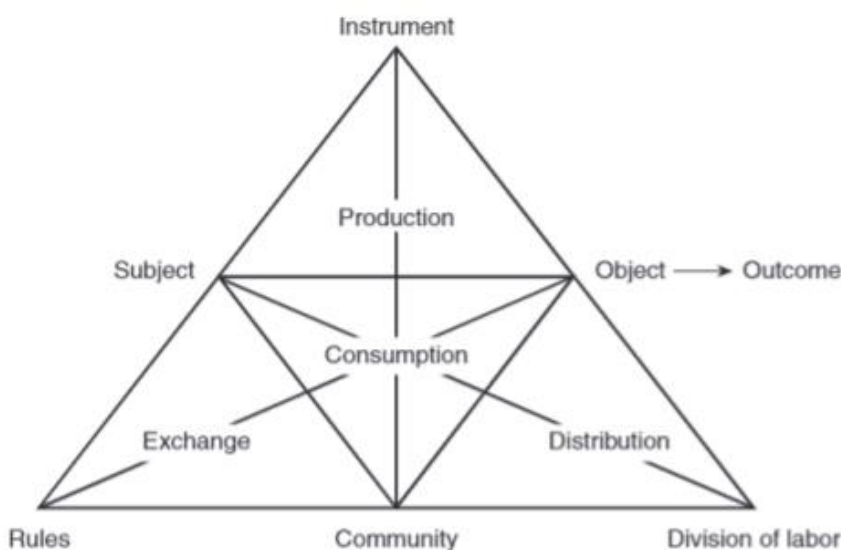


Figure 3 - Structure of human activity.

Source: (ENGESTRÖM, 2015, p. 63).

Engeström finally gets to "the structure of learning activity" (ENGESTRÖM, 2015, p. 101). In this framework, norms, community, and labor division make individual and communal interdependencies explicit. What the author calls the motivator of learning activities originates from the theoretical interaction with reality, as Davydov indicated in his research with Zinchenko: "[...] in the process of play activity, the child learns the broad meanings of human interrelations (their coordination and subordination)" (1981, pp. 43–44). He learns to visualize and substitute objects symbolically. Play's historical progression as an important form of a child's mental development has been studied from a psychological perspective. D. B. El'konin has shown that youngsters of certain primitive peoples use basic toys to gain general sensorimotor capabilities required for subsequently acquiring specific professional talents and skills. Play develops children's learning skills as production becomes more intricate (DAVYDOV; ZINCHENKO, 1981, p. 43).

This activity introduces the child to science, art, law, and morality, inculcating in him theoretical thinking

and orientation in the domain of higher forms of human consciousness. Under socialist conditions, cultural forms whose acquisition fosters the all-round development of the human personality in learning activities are developed.

Another research objective is to discover the psychological principles of all sorts of reproductive activity in the child by which he assimilates historically evolved general human skills (DAVYDOV; ZINCHENKO, 1981, pp. 43–44).

In Davydov and Zinchenko (1981) assertion, Engeström sees a theoretical relationship between learning's key tools and models. The learning process itself may be understood and used as a methodological model. Therefore, these theoretical models and methodologies let the subject develop his or her own learning model. According to these Russian authors, the subject employs models to fix and objectify crucial learning relationships. Although science and art produce theoretical models and techniques, their instruments cannot be taken directly because the activities they describe produce them to varying degrees. Science and art focus on making their own instruments. Labor activities also shape and manufacture instruments, but less intensely, so they rely more on instruments from other activities (Figure 4).

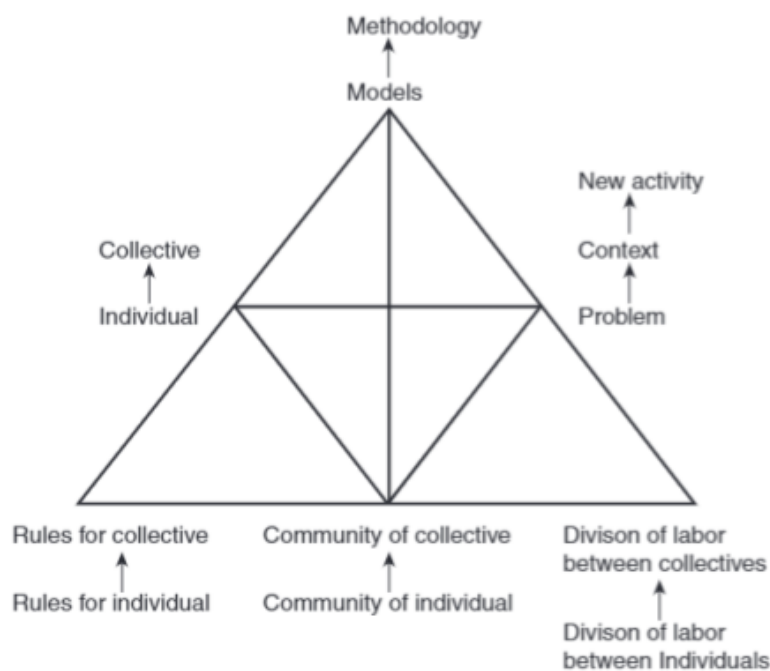


Figure 4 - Structure of the learning activity.

Source: (ENGESTRÖM, 2015, p. 101).

In this framework of learning activity, its essential quality, a transitional and expanded nature, is formed. This subject must have consciousness-related learning properties.

The next section talks about the problem of consciousness in learning, including metacognition, cognition, and theory of mind.

3. Results and Discussions

3.1 Findings about cognition, metacognition, and theory of mind

A bibliometric survey was conducted to contextualize the field of study and demonstrate the currentness of the empirical research conducted. The keywords "cognition", "metacognition", and "theory of mind", associated with Sternberg (2017), Flavell (1977), and Astington (1996; 2020), respectively. The database search was conducted on February 2, 2022, and only peer-reviewed articles published between the years 2017 and 2021 were considered.

The articles were selected by their respective abstracts, separated by those whose researchers stated that they held empirical research in their methodology. The concern with selecting empirical research rather than bibliographic, exploratory, and theoretical studies was due to the fact that our goal was to prioritize results from practical situation analysis, population observations, or case studies. With this, we have in mind the potential to confirm or refute the theories of the referenced seminal classics. So, we want to support the idea that topics related to cognition, especially metacognition and theory of mind, follow their own paths to prove Flavell's and Astington's theses.

3.1.1 Human cognition according to Sternberg

In his latest work on cognitive psychology, Sternberg (2017) recovers the entire study on the topic of cognition and updates his original thesis, published in the 1970s, in which the author conceptualizes: Cognitive psychology is the study of how people perceive, learn, remember, and think about information. A cognitive psychologist might study how people perceive various shapes, why they remember some facts but forget others, or how they learn language (STERNBERG; STERNBERG, 2017, p. 3).

Based on the studies by Sternberg et al., on which the most recent research is based, and adopting the indicated analysis structure, we found 4 articles, presented in Table 1.

Table 1 - Summary of findings in empirical research on cognition based on Sternberg's seminal thesis.

Expression: cognition AND Sternberg

Total articles located in the CAPES PERIÓDICOS portal, published between 2017 and 2021: 18

Number of articles that performed empirical research: 4

FINDING 1 of 4: "Results revealed significant correlations between school performance and all measures, except for attention. Students' performance on the cognitive tests explained up to 66% of their grades. Intelligence, language, and executive functions are associated with school performance, but language and executive functions, especially cognitive flexibility, can be considered as stronger predictors of performance in 5th grade. These findings can assist in the design and implementation of intervention programs to promote these skills" (DIAS; SEABRA, 2017, pp. 315–316).

FINDING 2 of 4: "The results indicated higher means in figural creativity and extrinsic motivation among students whose teachers use technology. The students from the schools that do not use technology reported more interest in learning. This study contributed to demystify the idea that the use of technology in teaching practice is an essential condition for the development of student's creativity and motivation" (BORGES;

FLEITH, 2018).

FINDING 3 of 4: “The results suggest that 3 months of Karate-Dō practice is related to a significant improvement of the cognitive functions in healthy older adults.” (FILHO; OLIVEIRA; GOTTLIEB, 2019).

FINDING 4 of 4: “The results of the analysis showed that the use of investigative experimental activities contributed significantly to the manifestation and evidence of skills ranging from low to high-order cognition.” (COELHO; MALHEIRO, 2019).

Source: The authors (2022).

Cognition, according to Sternberg, is how the subject perceives, learns, remembers, and thinks about the information they receive. The identified empirical studies stated the common objective of qualifying the quantity and/or effectiveness of learning in relation to some informational exposure factors, i.e., if there is any improvement in the quality of learning observed in the experiment in relation to an existing teaching practice. The researchers sought to understand how cognition behaves when faced with an informational exposure situation associated with an additional component, specifically physical, sensory, social, or curios stimuli. The results that have been seen point to more effective learning, more fun while learning, better cognitive resourcefulness in related learning activities, or a better understanding of concepts and practices.

3.1.2 Metacognition according to Flavell

In his seminal thesis on metacognition, Flavell (1979) studies cognitive development and states the following general definition:

Metacognitive knowledge consists primarily of knowledge or beliefs about what factors or variables act and interact in what ways to affect the course and outcome of cognitive enterprises [...] (FLAVELL, 1979, p. 907).

Table 2 presents the empirical research on metacognition results, which was theoretically based on Flavell's research.

Table 2 - Summary of findings in empirical research on metacognition based on Flavell's seminal thesis.

Expression: metacognition AND Flavell

Total of articles located in the CAPES PERIÓDICOS portal, published between 2017 and 2021: 18

Number of articles that performed empirical research: 6

FINDING 1 of 6: “With this, it was possible to affirm that knowing, feeling and valuing are related to the metacognitive process and that the planning of actions focused on learning, its monitoring and evaluation is influenced by the emotions and reflections of the students which emerge from contact with others and with the world” (CORRÊA; PASSOS; ARRUDA, 2017).

FINDING 2 of 6: “The results of this study indicated that through the Conceptual Maps (CM) it is possible to better understand the metacognitive manifestations of the individuals, since the maps make the information more accessible and allow understanding how the students understand the content in study and how they relate the concepts in their cognitive structure. Currently, there is an increasing use of alternative tools for the teaching, including in the field of natural sciences, where they are constants, thus, the use of

CMs was quite accepted by students, which contributed significantly to the training of future teachers, demonstrating the importance of this instrument for the teaching-learning process” (TAVARES; MÜLLER; FERNANDES, 2018).

FINDING 3 of 6: “No significant differences were found between the average performance according to the variables of sex, age and education of the participants. The analysis of the validity and accuracy indicated adequacy of the items and good internal consistency of the scale” (FRANÇA; SCHELIN, 2018).

FINDING 4 of 6: “The results indicate an improvement in the student's performance and attitude, with his active participation in the process, with propositions of strategies more appropriate to his study routine and better organization due to the metacognitive monitoring proposed in this study. Thus, it was found that it is possible to approximate the use of classroom portfolios with John Flavell's reference to metacognitive monitoring and that the portfolio, as well as its conduction by the teacher, had a positive participation in the learning process in the discipline of General Chemistry by the analyzed student” (LOCATELLI; ALVES, 2018).

FINDING 5 of 6: “This revision proposes that the metacognitive processes involved in historical understanding are especially susceptible to this type of motivational influence, by virtue of its epistemic characteristics and its social implications. This thesis is grounded in empirical evidence suggesting that ideological and identity commitments related to historical narratives can affect the way learners and experts monitor the quality of their understanding and control the application of their strategic knowledge when evaluating historical information” (MARTÍNEZ, 2019).

FINDING 6 of 6: “In the results obtained, the discussions established were favored by the awareness of students on their own knowledge and the executive control of the developing action. Additionally, the inquiry-based methodology provided freedom for exposing ideas, structuring and testing hypotheses, recalling previous knowledge, among other aspects associated with the activation of metacognitive thinking. Therefore, the study indicates the importance of associating metacognition to inquiry-based teaching so to enhance this methodological approach” (ROSA; VILLAGRÁ, 2020).

Source: The authors (2022).

According to Flavell, metacognition is how the subject uses one's own cognition to perceive the state or quality of one's cognition, indicating to him/her how it can be better stimulated and understood. This thesis permeated the six selected articles. The empirical studies shared the aim of identifying whether the controlled stimulation of metacognitive processes using the recurrent inquiry method somehow affects the effectiveness of learning through the possibility of questioning cognition itself. The selected surveys can be divided into two groups. In the first group, there are five research projects that make use of additional metacognitive register techniques, such as portfolio, conceptual map, and discursive register. The results of these studies indicated that by raising awareness of metacognition, the subject perceives that he has control over his own learning. This results in an improved quality of learning due to greater effectiveness in understanding concepts, phenomena, or practices. The second group, on the other hand, consists of only one article, Finding 3 of 6, which aimed to validate the measurement method proposed by Flavell for indicating the metacognitive scale.

The study showed that the Flavell method is correct and useful for the proposed measurements.

3.1.3 Astington's Theory of Mind

In his theory of mind, Astington studied the individual's mental representations. He described them as the ability to attribute and represent independent mental states (beliefs, intentions, desires, or knowledge) in oneself and others and to understand that others possess such states distinct from one's own comprehension (ASTINGTON, 1996; ASTINGTON; DACK, 2020).

This sense of 'theory' is evident in the simulation theorist's assumption that although children's understanding is dependent on a system of mentalistic concepts, of belief, desire, intention, and so on, the system is not developed via some process of abstract theorizing. The concepts are derived from children's own direct experience of such states. On this view, even young children can introspect their own mental states and are intuitively aware of their own phenomenal experience. They can then understand other people by a process of simulation, using their abilities for pretense which they develop early in the pre-school years. That is, the child imagines herself having the beliefs and desires that the other person has and imagines what she herself would do if she possessed those imagined beliefs and desires (ASTINGTON, 1996, pp. 184–185).

Table 3 shows the results of empirical research on the theory of mind, which were based on Astington's research.

Table 3 - Summary of findings in empirical research on theory of mind based on Astington's thesis.

Expressions: "theory of mind" AND "Astington"

Total number of articles on the CAPES PERIÓDICOS portal, published between 2017 and 2021: 9

Number of articles that performed empirical research: 3

FINDING 1 of 3: "The results showed a positive but weak association between theory of mind and language, a finding which converges with previous research. Possible variables that may motivate differences in children's social cognitive development are discussed" (SILVA; RODRIGUES, 2018).

FINDING 2 of 3: "Results suggest that the phenomenon is associated with a more developed receptive vocabulary and is not indicative of deficits in social cognitive development" (VELLUDO; SOUZA, 2018).

FINDING 3 of 3: "At the end of the study, it was found that there was a significant and positive relation between the total creativity score and the sub-dimensions of theory of mind. It was found that there was a significant and positive relation between all sub-dimensions of creativity and theory of mind. The total creativity score and the scores of the sub-dimensions of creativity (fluency, originality, and elaboration) were significant but weak predictors of theory of mind tasks" (ÖZSEVGEÇ; AZAKLI, 2021).

Source: The authors (2022).

According to Astington, the theory of mind indicates how the subject generates within itself the engagement to interpret the cognition of another and to attribute and represent what another knows, thinks, or realizes. Astington came up with ways to measure how a subject uses creativity in the learning process based on Vygotsky's research on how a person's social interactions lead to learning.

The theory of mind was at the center of the assessments, and the researchers sought to understand how creativity was related to the process of learning development, but now from the theory of mind perspective. The results showed that subjects with higher cognitive proficiency did not indicate low socio-cognitive development. Furthermore, according to research, subjects with higher than average vocabulary development in childhood (6-7 years old) do not have an advantage over others in terms of sociocognitive development. Lastly, the results showed that people who live in rural areas and have more direct contact with natural elements are more creative than people who live in cities and have more contact with artificial elements.

In this context, recent findings from the bibliometric survey indicate that empirical research was conducted based on the concepts of cognition, metacognition, and theory of mind. This research confirms the theories themselves, whose concepts refer to the feeling in the individual learner that in his mind, whenever something new is learned, a skill developed, or mental vitality regained, a sense of innovation in himself is awakened. The results of the surveys are summarized in Table 4.

Table 4 - Summary of findings in empirical research on cognition, metacognition, and theory of mind.

Applied Theory	Basis of the experiment	Results
Human cognition in Sternberg (2017).	Informational exposure associated with physical, sensory, social, and curiosity stimuli.	Greater learning effectiveness; higher levels of enjoyment in the act of learning; better cognitive resourcefulness in related learning activities; and a higher quality of apprehension of concepts and practices.
Metacognition in Flavell (1977).	To identify whether the controlled stimulation of metacognitive processes, performed by the subject's awareness of them via the recursive inquiry method, affects the effectiveness of learning in any way.	The subject's awareness of its own metacognition enables the perception of control over what is learned. That results in an improvement in learning quality by virtue of the greater effectiveness in the understanding of concepts, phenomena, or practices.
Theory of Mind in Astington (1996).	From a theory of mind perspective, how does creativity relate to the learning development process?	Subjects with greater cognitive resourcefulness did not present indications of low social and cognitive development; subjects with higher than average vocabulary development in childhood (6-7 years old) did not have an advantage over others in terms of social and cognitive development; and subjects who had more direct contact with natural elements (rural inhabitants) showed greater creative ability when compared to children who had more contact with

artificial elements (urban inhabitants).

Source: The authors by summarizing the results in each group of selected articles

3.2 Identified concepts about teaching methodology

To demonstrate some understanding of "Teaching Methodology," we compiled the statements of peer-reviewed scientific articles published in the last 5 years (between 2017 and 2021). All of them are related to the group of publications about learning, and the search term "teaching methodology" was used to find and sort them.

The search was performed on the CAPES PERIÓDICOS portal on February 2, 2022, and returned a total of 38 results. All the abstracts were read. Those that indicated the application, selection, and/or analysis of teaching methodology as their objective had their introduction read to verify what the researchers' understanding of teaching methodology was. The findings were selected and the understanding was extracted and included in Table 5.

Table 5 - Summary of the understandings found on "Teaching Methodology".

Expression: "Teaching Methodology"

Group of filtered publications: Learning

Total articles located in the CAPES PERIÓDICOS portal, published between 2017 and 2021: 38

Number of articles that met the filtering criteria: 6

UNDERSTANDINGS 1 of 6: (BATISTA, 2016)

"[...] teaching methodology should be above any question in terms of education."

"[...] teaching methodology must guide the teacher's actions in school institutions."

"[...] to implement such strict methodological control over the school, the programs, the curriculum, the student and, above all, the teacher, that, as a consequence, would appear only as an executor of a plan previously and absolutely resolved by the teaching methodology."

"As has been the subject of reflection in Psychoanalysis and Education, it is necessary, if an education is to become possible, for the teacher to subjectively engage with the content and even with the methodology used in teaching (thereby placing "something of oneself" in them)."

UNDERSTANDING 2 of 6: (OLIVEIRA, K. R. E. De *et al.*, 2018)

"The Institution 1 was selected because it adopts a traditional teaching methodology, although it also used other teaching learning methods, such as students presenting and elaborating seminars. The Institution 2 was selected because it only adopts active teaching-learning methodologies."

"When we seek to understand how the development of communicative skills occurs in nursing students, we noted this is influenced by several factors, such as: experience in practical activities, their individual characteristics, the access to mass media, the relation of proximity established with the professor and the knowledge on theoretical concepts of communication and nursing. These are influencing factors, from the perspective of teachers, regardless of the teaching methodology used."

UNDERSTANDING 3 of 6: (CADÊTE; PEIXOTO; MOURA, 2021)

"The sample consisted of 147 4th-year medical students from schools with different teaching methodologies: 73 students from Institution A (Problem-based learning - PBL) and 74 students from Institution B (traditional methodology)."

"The literature points out several factors related to the school environment capable of influencing the motivation for learning, and among them, one of the most important is what occurs in the classroom, from the didactic materials used, the teaching methodology employed, and the affective factors seen in teacher-student relationship 33, 34."

UNDERSTANDING 4 of 6: (OLIVEIRA; MORAIS, 2019)

"Physics teaching has presented many difficulties in schools, both in relation to the students' performance in learning content and the teachers' teaching methodology, which may not be sufficient for student learning."

"1st Question: What teaching resources do you use to teach your classes and what is your teaching methodology? Teacher A: I most often use the traditional chalkboard. Lately I've been using Datashow to present figures and diagrams and also to make the classes more dynamic. When the theme allows me, I usually present some experiments. Teacher B: Based on a private school: Textbook, in which students follow the enunciation of exercises and problems, because all the content taught is exposed on the blackboard with white and colored chalk; In this institution we have laboratories of mechanics, thermodynamics, optics and electricity, then experiments are prepared using these laboratories, being mandatory the delivery of a report of the lesson taught; We adopt list of exercises to review all the content taught, in each bimester, and each bimester we have two assessments; I use little multimedia resource. For the next few years, we have adopted a collection from Editora Moderna, which has a digital platform available to work on simulations of real phenomena, with online assessments. Based on the public school system: Use of textbook provided by the MEC teaching system All content is taught in the form of exposure on the board using a brush. Resolution of exercises and problems are also exposed on the board; We have no laboratory available; We use exercise lists to review content for the bimonthly exams."

"When analyzing the teachers' answers, provided through the questionnaires, it can be inferred that both have a similar teaching methodology, in which they use the traditional blackboard and chalk, with classes followed by the textbooks provided by the institution. One difference between teachers A and B, is that one tries to work with new methods and technology devices and the other does not, where he prefers the traditional one, by solving exercises in class and with dialogued-oriented classes."

UNDERSTANDING 5 of 6: (SAMPAIO; SAMPAIO, 2020)

"Methodologies for Teaching Geography in School: Municipalities of Araguari, Campo Florido, Prata, Uberlândia and Uberaba, Minas Gerais, Brazil. 2013-2017. Expository class; Directed Study; Discussions; Research".

UNDERSTANDING 6 of 6: (OLIVEIRA, B. L. C. A. De *et al.*, 2018)

"Thus, students were initially offered information about Team-based Learning (TBL), showing its basic concepts and characteristics, such as its phases and stages and the evaluation system, to provide an overview of resources and benefits of this teaching methodology for the students involved."

Source: The authors by collecting the understandings indicated in the selected articles

In compiling the understandings found in "Teaching Methodology", there is a common direction followed by all the articles. In general, they consider it to be a set of procedures adopted by the teaching staff to present conceptual, attitudinal, and practical content to the students. In this way, it not only promotes the understanding of its applicability but also allows students to extrapolate what was learned and apply it in other contexts autonomously, either in work activities or in their individual, social, and professional lives.

4. Conclusions and Limitations

From the arguments of the theories, inferences, and possibilities that we have discussed in this study, we have elaborated on five hypotheses about a possible methodological proposal. They are:

Hypothesis 1: Human curiosity is, at first, external to the individual, and he allows himself to be led by it towards the discovery of possibilities by means of several attempts interspersed with mistakes and successes (SCHUMPETER, 1997). This can generate an underlying mental model that, in turn, may lead to an unprecedented paradigm for the individual (LAZZAROTTI; DALFOVO; HOFFMANN, 2010), whose very novelty will serve as a springboard in the search for new knowledge (ENGESTRÖM, 2015) and make it easier for you to turn on within yourself;

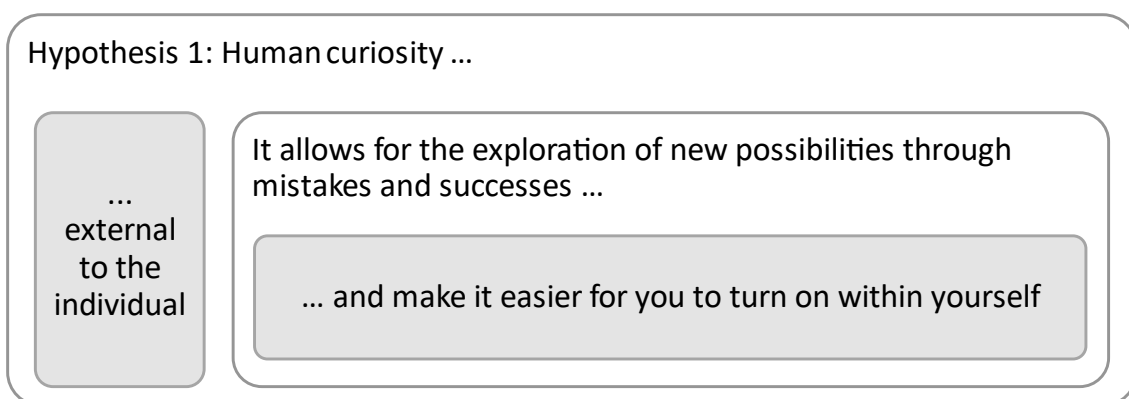


Figure 5 - Structure of the hypothesis 1 – human curiosity

Source: the authors

Hypothesis 2: This same curiosity that drives the individual will tend to awaken in him the perception and sensation that manifest in the mind as what Piaget called an "[...] external frame to use it as a reference, while at the operative level [...]" (PIAGET, 1977, p. 22). In other words, the mind will operate with innovation, starting from curiosity as a springboard, giving the necessary impulse to reach understanding, as a feeling will

be associated with it;

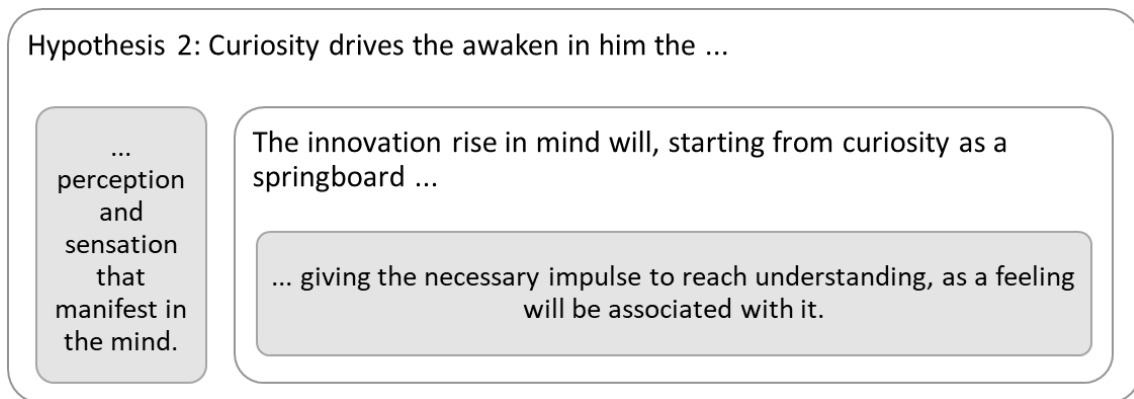


Figure 6 - Structure of the hypothesis 2 – curiosity as a drive

Source: the authors

Hypothesis 3: Social relations as an interpsychic function, related to intrapsychic function (LEONTIEV, 1981), explains how the formation of cognition by recurrent, assisted, and socially coordinated practice leads focus to the learning mechanism. This places the individual as the protagonist of these relationships. Protagonism awakens feelings of pride, power, control, and appreciation, which contribute to making the individual an inseparable part of the learning process (WENGER, 1998).

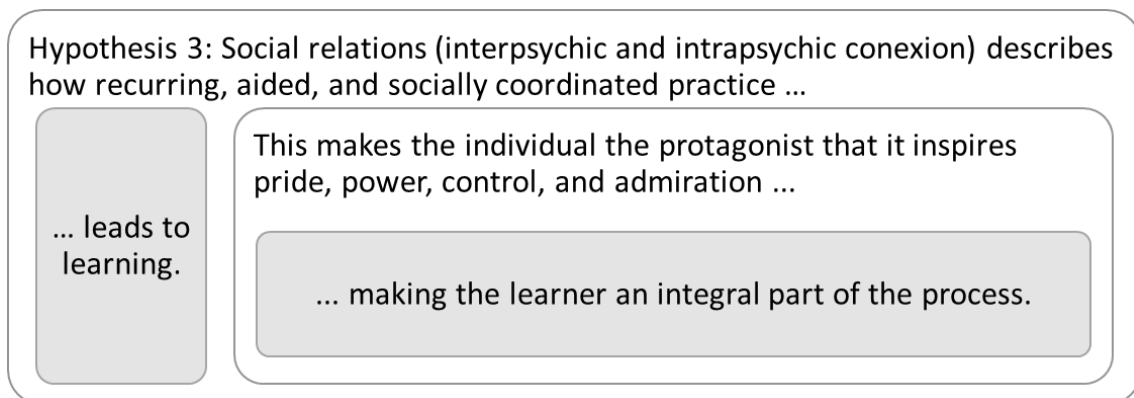


Figure 7 - Structure of the hypothesis 3 – leads to learning

Source: the authors

Hypothesis 4: Cognitive experimentation to overcome the challenges of creating models that lead to effective (individualized) learning methodologies (ENGESTRÖM, 2015) is supported by recent findings on theory of mind. It states that whenever something new is learned, the perception of innovation is awakened in the individual (ASTINGTON, 1996; ASTINGTON; DACK, 2020; ÖZSEVGEÇ; AZAKLI, 2021; SILVA; RODRIGUES, 2018; VELLUDO; SOUZA, 2018). It is this innovation of the subject that arouses a sense of relief and leads to tranquility;

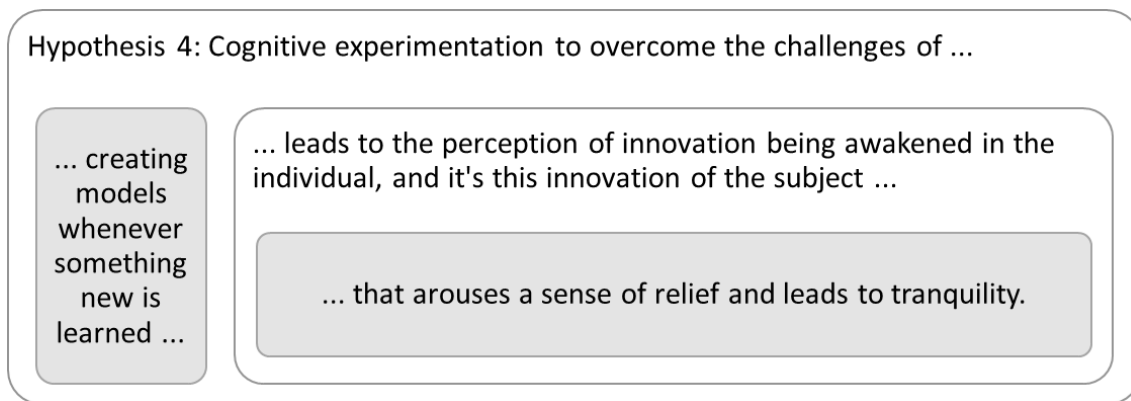


Figure 8 - Structure of the hypothesis 4 – cognitive experimentation

Source: the authors

Hypothesis 5: The compilation of understandings on Teaching Methodology clarify the necessary components for a methodology to be proposed, delivering the list of items it needs to present (BATISTA, 2016; CADÊTE; PEIXOTO; MOURA, 2021; OLIVEIRA, B. L. C. A. De *et al.*, 2018; OLIVEIRA, K. R. E. De *et al.*, 2018; OLIVEIRA; MORAIS, 2019; SAMPAIO; SAMPAIO, 2020).

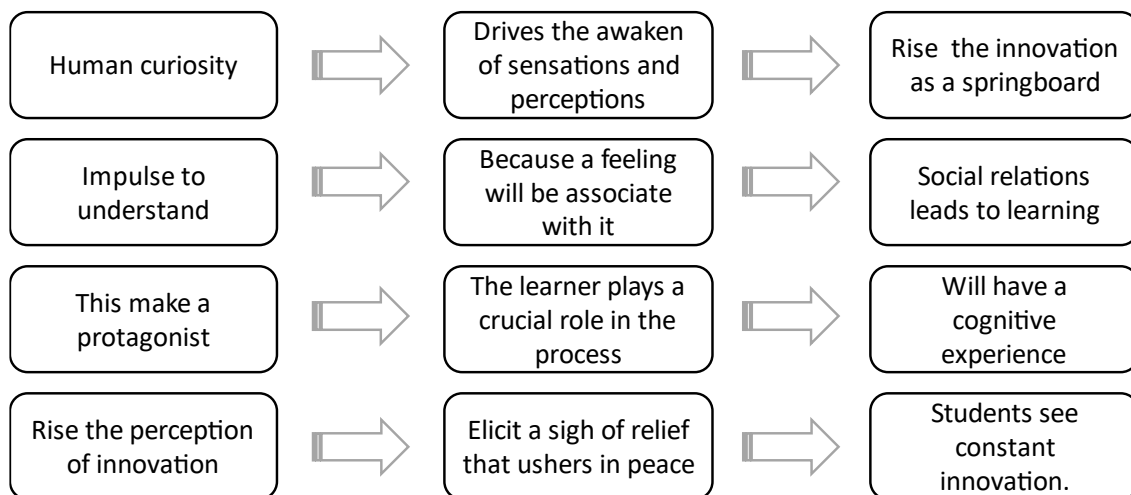


Figure 9 – Steps to understand the learn processes as a permanent innovation

Source: the authors

If we organize these five hypotheses as a method for didactic work and pedagogical orientation, we can make a methodological proposal because this research has all the pieces, we need to build it:

- The theoretical foundations and the experiments that support them;
- The necessary operating assumptions;
- The stages of learning;

The present research is limited to answering the question and bringing the elements of theoretical support. The development of a methodological proposal based on its results is a sign of what needs to be done in the future. Other limitations that can be included throughout the results analysis are listed below in one list. This is not a full list, but some items can be considered.

- The lack of a representative sample, which may affect the generalizability of the results to the general population;
- The lack of objective measures to assess the success of a hypothetical methodological proposal;
- The lack of follow-up studies to assess the long-term effectiveness of the methodological proposal;
- The possibility that some of the theories or experiments used are not widely accepted or are not considered solid scientific evidence;
- Failure to consider other perspectives or approaches relevant to the subject;
- Lack of consensus among specialists on how to best approach the subject, despite the fact that the seminal authors referenced have a great reputation in the scientific community;
- The eventually limited scope of the research, which may not fully capture all aspects of the subject;
- The lack of practical implementation of the proposed method, which is recommended for future research but may not have been tested in a real-world setting, because expertise is people learning in a scholar context, which means formal education, there is the possibility of bias in the selection of theories and experiments used to support hypotheses;
- Possibility of limited generalizability of the findings to other populations or contexts, considering other theories;
- The potential for future research to contradict or build upon the current findings other limitations that can be included throughout the results analysis are listed below in one list.

5. Acknowledgement

5.1 Statements and Declarations

I, Marcus Garcia de Almeida, corresponding author, declare on behalf of the other authors, that the article: "**Learning as a permanent innovation: advances on studies of the intellect**" is original and unpublished, as well as express agreement with the International Journal for Innovation Education and Research (IJIER). Declaration, which will apply in case of publication of the aforementioned work. I also declare that all authors presented here DO NOT HAVE CONFLICT OF INTEREST of order:

- Staff,
- Commercial,
- Academic,
- Political
- Financial in the manuscript.

And that all information that could lead to a conflict of interest has already been requested and expressed during the submission process of the aforementioned manuscript or in agreement markings during the submission process on IJIER platform.

5.2 Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Marcus Garcia de Almeida. The first draft of the manuscript was written by

Marcus Garcia de Almeida and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

5.3 Other Request Information

5.3.1 Current Themes of Research

The "Current Themes of Research" in the field of Psychology of Education are listed below:

- Relation between type of attention stimuli and basic emotions. We are in collect phase of data with undergraduate students of Information Management degree in Universidade Federal do Paraná (N=100).
- Phase of data analysis of collected data about cognition, metacognition and theory of mind with undergraduate students (N=40) of one private university center located in Curitiba metropolitan areas. We are searching if there are some relations between metacognition and engagement when use didactic method Problem Based Learning (PBL) with students.

5.3.2 Publications in Current Theme of Research

In order to inform the research area of publishing and research, are listed below the DOI links to view published papers.

- KUABARA, P. S. S.; BRASILEIRO, B. L.; MENEZES, G. G. DE. Distance Education at the Federal University of Paraná, Brazil Organization and Evaluation of Pedagogical Work. 2014 International Conference on Web and Open Access to Learning (ICWOAL), p. 1–6, 2014. doi: <https://doi.org/10.1109/icwoal.2014.7009213>
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- MISCHIATTI, J. A. W.; PUPO, F. P.; MENEZES, G. G. DE; TSUNODA, D. F.; SILVA, H. DE F. N. Advantages and disadvantages of using the problem-based learning method - PBL for upper level students in business areas. *International Journal for Innovation Education and Research*, v. 7, n. 11, p. 850–860, 2019. <https://scholarsjournal.net/index.php/ijer/article/view/1941>
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- MAIA, M.; FREITAS, M. D. C. D.; MENEZES, G. G. DE. ENSINO APRENDIZAGEM: PRÁTICA EDUCATIVA NO ENSINO MÉDIO DE CONTEUDO DA DISCIPLINA DE MATEMÁTICA. *Revista Mundi Sociais e Humanidades* (ISSN: 2525-4774), v. 1, n. 2, 2017. <https://doi.org/10.21575/25254774rmsh2016vol1n2116>

5.4 CRediT

Conceptualization: Marcus Garcia de Almeida; Data curation: Marcus Garcia de Almeida; Formal Analysis: Marcus Garcia de Almeida; Funding acquisition: Marcus Garcia de Almeida; Investigation: Marcus Garcia de Almeida; Methodology: Marcus Garcia de Almeida; Project administration: Glauco Gomes de Menezes; Resources: Marcus Garcia de Almeida; Software: Marcus Garcia de Almeida; Supervision: Glauco Gomes de Menezes; Validation: Marcus Garcia de Almeida; Visualization: Marcus Garcia de Almeida; Writing – original draft: Marcus Garcia de Almeida; Writing – review & editing: Marcus Garcia de Almeida and Glauco Gomes de Menezes;

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