

Contributions of the Galperin, Talízina and Majmutov to the didactic system through the Student Problem Situations Activity in the learning of mathematics in Elementary School students

Contribuições do sistema didático Galperin, Talízina e Majmutov por meio da Atividade de Situações Problema Discente na aprendizagem da matemática em estudantes do Ensino Fundamental

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ABSTRACT

The purpose of this article is to analyze the contributions of the Student Problem Situations Activity based on the theories of formation by stages of mental actions and Galperin's concepts, in the direction of Talízina's study activity and in the problem-solving teaching of Majmutov in the learning of mathematics in students from elementary education in schools in the municipality of Boa Vista, Roraima. Based on qualitative procedures and methodological research studies, advances were made in learning mathematics content. The results were obtained from studies carried out by the Research Group "Didactics of Problem Solving in Science and Mathematics" linked to the Federal

RESUMO

O objetivo deste artigo é analisar as contribuições da Atividade de Situações Problema Discente fundamentada nas teorias de formação por etapas das ações mentais e dos conceitos de Galperin, na direção da atividade de estudo de Talízina e no ensino problematizador de Majmutov na aprendizagem da matemática em estudantes do Ensino Fundamental em escolas do município de Boa Vista, Roraima. A partir de procedimentos metodológicos qualitativos e quantitativos de pesquisa se conseguiu obter avanços na aprendizagem nos conteúdos de matemática. Os resultados foram obtidos por estudos realizados pelo Grupo de Pesquisa "Didática da Resolução de Problemas em Ciências e Matemática" vinculado à Universidade Federal de Roraima e ao Mestrado

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1 Introduction

This manuscript describes the results of studies conducted over the last 10 years (2012-2021) by the research group entitled *Didática da Resolução de problemas em Ciências e Matemática (Didactics of Problem Solving in Science and Mathematics)*, linked to the federal and state universities of Roraima (UFRR and UERR). The research presented here focuses on Basic Education, more specifically, on Elementary School, Early and Late Years (1st to 9th grade).

The article refers to the Historical-Cultural Theory pioneered by Vygotsky and is based on Leontiev's Theory of Activity. More specifically, it is based on the Didactic System composed of P. Ya Galperin's Theory of Stages of Mental Action Formation, Talízina's Direction of Study Activity, and Majmutov's Problematizing Teaching. Its main objective is to analyze the contributions of Student Problem Situations Activity (SPSA) to mathematics learning among elementary school students in schools in the municipality of Boa Vista, Roraima, based on the Galperin-Talízina-Majmutov Didactic System.

It is worth noting that, according to the National Common Core Curriculum (Base Nacional Comum Curricular-BNCC), mathematical knowledge is necessary for all students in basic education, both for its application in society and for its potential in forming critical citizens who are aware of their social responsibilities. The BNCC points out the importance of ways of organizing mathematical learning, highlighting the analysis of everyday situations, other areas of knowledge, and mathematics itself (BRAZIL, 2018). At this point, it is understood that the methodology adopted by the teacher plays a relevant role in the teaching and learning process, and the Problem Solving methodology is presented, as it allows mathematics to be worked on in a contextualized way.

Among the materials selected for the literature review in this study are final course papers, monographs, and dissertations, whose research was conducted in public schools in the municipal, state, or federal networks. The criterion for selecting the works developed by the aforementioned research group, in addition to elementary school, was the adoption of Activity Theory and Problem Solving as a teaching-learning strategy.

2 Theoretical foundation

According to Historical-Cultural Theory, humans can only be understood if we consider their history, context, and culture, as their consciousness is formed through relationships with other people and through their activities. For this reason, Wittmann and Klippel (2010) assert that each individual carries within their subjective conditions characteristics of time, space, society, and the social group in which they were raised. It is from this perspective that students should be understood as social and historical beings, and teachers should be attentive to the particular characteristics of students in the teaching-learning process (FEITOSA, 2014).

Vygotsky (2003a, 2003b), a pioneer of Historical-Cultural Theory, pointed out important concepts to explain levels of development: Zone of Actual Development, Zone of Proximal Development (ZPD), and Zone of Potential Development. When adopting the concept of the ZPD, Vygotsky defined it as the distance between the level of Actual Development (what the student does independently—what they already know) and the level of Potential Development (determined by the actions that the student performs with the help of an adult or another more experienced colleague). At this point, the teacher's role is to act as a mediator between the student and the process of knowledge acquisition (MAGALHÃES, 2021). It is through mediation that the internalization (internal reconstruction of an external operation) of socio-historical and cultural activities and behaviors takes place, and this mediation includes the use of instruments and signs (VYGOTSKY, 2003a; MOREIRA, 2011; NUNES NETO, 2015).

Talízina (1988), a researcher in Historical-Cultural Theory, raised some criticisms of the theory in the sense that it does not establish a direct relationship between the psyche and the practical activity of the subject. In this regard, the author highlighted the following:

It limits itself to researching instruments as the fundamental process of internalization; it does not analyze the influence that new relationships between people have on human psychology in the process of work activity; it does not establish a clear relationship between the subject and the external world in the formation of psychic functions; it does not consider the subject's activity with the world of objects as the decisive step in the process of assimilating concepts (NUNES NETO, 2015).

The overcoming of these points and the presentation of the foundations of the principle of the unity of the psyche and activity can be found in the works of Rubinstéin, Leóntiev, Talízina, and their collaborators.

In Leóntiev's Theory (2004), students relate to the world through activity, which is composed of actions, and each action is composed of respective operations aimed at achieving a goal. It is important to note that Leontiev recognized in Vygotsky's work that internal or mental activity is a reflection of external or material activity, but he did not indicate how this transformation occurs. Galperin (1982) pointed the way through his Theory of the Staged Formation of Mental Actions, in which he presented five qualitative stages:

➤ E0—Motivational: There must be an objective need that drives the subject to action. According to (LONGAREZI; PUENTE, 2013, p.90), “the motive arises from the encounter between the need and the object; it is the motive that drives the activity, since objects and actions alone are not capable of initiating it.”

➤ E1 - Setting up the Guiding Action Base (GAB): This is where we try to get students started on the process of taking in knowledge. At this stage, the teacher organizes the didactic sequence and guides the student in the assimilation process, in the actions they should follow (TALÍZINA, 1988, p.58). In other words, the teacher guides the student according to the objective they want to achieve.

- E2 - Action creation in material or materialized form: students actively work based on the guidelines they receive, and activities can be carried out using material resources (real objects) or materialized resources (representations: drawings, photographs, etc.), allowing students to assimilate the content of the practical activity and enabling them to move on to the next level (RIBEIRO, 2012). Bassan (2012) points out that at this stage, students can carry out the activity in pairs or groups and be monitored by the teacher.
- E3 - Creation of external verbal action: the student is able to explain what they are doing. This verbalization can take place in various forms: written, gestural, verbal, musical. In this sense, through verbalization, the student propagates the action (BASSAN, 2012).
- E4 - Creation of action in external language: the student expresses the concept internally and is able to apply it to different situations; that is, they have the ability to generalize. Here, internal language becomes a mental function and provides new means for thinking.
- E5 - Creation of action in internal language: students acquire the ability to explain their reasoning using concepts in different situations. This stage is also known as automation.

After going through all these stages, learning becomes automatic. Automation not in the mechanical sense, but in the sense of acquired habit/concept, that is, it refers to independence.

It is worth noting that psychology focuses on human activity, which is the central unit of a person's life; it is “[...] the vital breath of the corporeal subject” (Leontiev, 1978, p. 75). According to Magalhães (2021), the introduction of this category in psychology allows us to consider it inserted in the reality of the object and how its transformation occurs in the subjective question. With regard to the school context, Mendoza and Delgado (2018) emphasize that students become familiar with the object of study through activity, which allows them to internalize the study and find solutions to the proposed tasks. In this vein, we will now discuss

the psychological and didactic foundations of Majmutov's Problem-Based Teaching and the Problem-Solving methodology, which argue that

The theory of teaching methods can only be created with the support of dialectical logic and learning theory, which is based on the principle of forming new concepts and modes of action through dialectical means, that is, by resolving contradictions [...] In the teaching and learning process, there is a system of contradictions that can be divided into three main groups: the contradictions of learning, those of the teacher's activities (teaching), and those of learning (the student). These are interrelated and pass from one to another. [...] If contradictions are a driving force in teaching, they must also be a means of resolving them (MAJMUTOV, 1983, p. 312, our translation).

When presenting Problematic Teaching, Majmutov (1983, p.125) argues that teaching should build cognitive independence and develop creative abilities in students, thus conceiving intellectual autonomy. He also points out that cognitive activity is related to the acquisition of new knowledge and the revelation of the essence of new concepts, and that these are possible through problem solving.

Based on activity theory, the concepts of task (with a problematizing focus), student problem situation, student problem, and student problem activity situations are different. The task should be presented to the student as an objective contradiction between known and unknown knowledge within the zone of proximal development. When the student realizes that their knowledge is insufficient to solve the task, then the objective contradiction becomes subjective, giving rise to the student problem situation. Then, if the students express the difficulty that prevents them from solving the task, the student problem appears. In this context, the student problem situation activity consists of actions combined with the motives and needs to provide answers to the task.

From this perspective, problem-based teaching should propose tasks that gradually challenge students and lead them to overcome stages. In the words of

Majmutov, “[...] problem-based teaching represents a special type of mutually conditioned activity between the teacher and students, which is determined by a system of problematic situations” (MAJMUTOV, 1983, p. 346).

In highlighting the psychological state of intellectual difficulty, Majmutov indicates that it is characteristic of Problem-Based Learning, and that it occurs whenever a human being sets out to solve a problem for which their knowledge cannot explain the fact, or when the procedures they know are not sufficient to solve the problem. At this point, it will be necessary to think of a new procedure/strategy for the solution. Here, the author presents the objective contradiction between the known (what is already known, understood—procedures, data, concepts) and the unknown (what needs to be known to solve the problem).

According to Magalhães (2021),

[...] it is necessary to awaken students' cognitive interest and ensure that the proposed difficulty is part of the body of knowledge they have internalized. From this perspective, problem-based teaching creates conditions for students to learn to produce new knowledge critically and consciously, building and expanding their intellectual autonomy. In addition to familiarizing them with mathematical ideas and concepts, it provides them with the conditions to develop fundamental learning skills and attitudes, such as developing different solution strategies, validating solutions, taking an interest in the work developed, and feeling confident about learning. Based on these actions, there will be greater possibilities for incorporating knowledge into the learning process (MAGALHÃES, 2021, p. 25).

In general, it is pointed out that Problem-Based Learning is not limited to stimulating learning but is configured as a possibility for the appropriation and production of knowledge, in order to drive mental advancement and contribute to the construction of a system of mental actions. On the subject of systems of actions, we will now discuss the didactics of problem-solving, based on which a system of actions for working on the learning of concepts is presented.

At this point, the Zone of Proximal Development stands out, highlighting the important mediating role of the teacher between the problematizing task and the student through the study activity. To mediate, the direction of the study activity proposed by Talízina (1988) is used, which suggests the consideration of the following elements: a) the teaching objective; b) the starting point of the students' mental activity; c) the tasks to ensure the stages of the assimilation process; d) the return link or feedback; and e) the correction of the study process.

The Research Group “Didática da Resolução de problemas em Ciências e Matemática (*Didactic of Problem Solving in Science and Mathematics*),” which develops its work based on the foundations mentioned above, is certified by the Universidade Federal de Roraima (UFRR) and has conducted research in conjunction with the doctoral programs in Education and Mathematics of the Rede Amazônica de Educação em Ciências e Matemática (REAMEC). Professional Master's Degree in Science Teaching and Academic Master's Degree in Education at the State University of Roraima (UERR) and Professional Master's Degree in Physics Teaching at UFRR. The group also includes research conducted by academics with degrees in Mathematics and teachers from the Application College, both linked to UFRR.

The group aims to explain the dialectical relationship between the teaching-learning process of concepts, procedures, and attitudes in the formation of mental actions and student creativity through problem-based teaching. To this end, it works to build a system of mental actions appropriate for teaching science and mathematics in the Amazon, based on Galperin's Theory of the Stages of Mental Action Formation, Talízina's Direction of Study Activity, and Majmutov's Problem-Based Teaching.

The group was officially established in 2017, but research began in 2006 based on studies of inquiries conducted by Talízina:

The problem of ways of thinking and procedures for solving tasks has long attracted the attention of psychologists and methodologists. Several studies specifically dedicated to this problem have been carried out on mathematical content. These studies investigate the role of knowledge and other factors that contribute to the formation of ways of thinking, establish some characteristics of the methods, and develop rules and guidelines to help students “use” the necessary procedure (TALIZINA, 1988, p. 201, our translation).

The same author adds:

The characteristic feature of these investigations is that the activity is not performed or arises from its formation as an activity with certain content and certain qualities. In addition, these tasks tactically assume that students are capable of performing the necessary activity. If thinking is considered to be a certain abstract function that already exists, the task consists only of making it work in the necessary direction. Among the works in this group, those by Polya are the best known (TALIZINA, 1988, p. 202, our translation).

Mendoza (2009), based on Talízina's criticism, converts Polya's principles (2006) into a study activity consisting of the following actions: understanding the problem, constructing the mathematical model, solving the mathematical model, and interpreting the solution, where each action consists of operations (see chart 1). This system of actions aims to solve problems in mathematical content and has been called Problem Situation Activity (PSA) in Mathematics.

Chart 1 – Problem Situation Activities in Mathematics

Action	Operations
Understanding the problem	Read the problem and extract all unknown elements. Study and understand all unknown elements. Establish data and its conditions. Establish the objective(s) of the problem.
Building the mathematical model	Identify variables and unknowns. Name variables and unknowns with corresponding units of measurement. Build the mathematical model based on variables, unknowns, and conditions. Analyze the units of measurement of the mathematical model.
Solving the mathematical model	Choose the mathematical methods to solve the mathematical problem. Choose the algebraic computing system that contains the necessary resources of the mathematical method(s) to solve the mathematical model (when necessary). Solve the mathematical model.
Interpret the solution	Interpret the result and obtain from the solution the mathematical model. Extract the relevant results that are related to the objective(s) of the problem. Provide answers to the objective(s) of the problem. Prepare a report based on the objective(s) of the problem. Analyze, based on new data and conditions directly related to the objective(s) of the problem(s), the possibility of reformulating the problem, rebuilding the mathematical model, solving the mathematical model and interpreting the solution.

Source: Mendoza (2009)

The PSA in Mathematics was used as a teaching methodology, i.e., mathematical content is presented as a justification for solving the problem. The theoretical basis was Galperin's Theory of the Stages of Mental Action Formation and Talízina's Direction of Study Activity. The PSA in Mathematics was also adapted for application in the field of Physics. On the official website (<https://w3.dmat.ufrr.br/hector/>) of the research group “Didática da Resolução de problemas em Ciências e Matemática (*Didactics of Problem Solving in Science and Mathematics*),” you can find research reports in articles, book chapters, proceedings, doctoral theses, master's theses, and graduate course final projects.

Starting in 2015, the research group began to introduce Majmutov's Problematic Teaching into the discussions. Silva (2016) presents the first complete research study using Majmutov. In this case, the study was applied to medical education.

Mendoza and Delgado (2018, 2020, 2021) modified the PSA in mathematics by introducing Majmutov's Problem-Based Teaching, renaming it Student Problem Situation Activity (SPSA).

The Student Problem Situations Activity as a study activity is modeled on the development of skills and abilities in solving student problems, in a teaching and learning context, in which there is interaction between the teacher, the student, and the problem-solving task in the zone of proximal development, with the use of available technology and other didactic resources, to move through the stages of mental action formation. A problem-solving task is understood to be one that presents an objective contradiction between known and unknown knowledge (MENDOZA, DELGADO; 2021, p. 237 - 238).

SPSA (see chart 2) emphasizes the formulation of the student's problem, where the teacher plays a fundamental role as mediator:

Chart 2 – Student Problem Situation Activity

Action	Operations
Formulating the student problem	Determine the known elements from the data and/or conditions and/or concepts and/or procedures of the task. Define unknown elements based on the data and/or conditions and/or concepts and/or procedures of the task. Recognize the contradiction generated by the problem situation. Determine the knowledge desired and/or the objective. Express the contradiction between known and unknown knowledge
Building the conceptual and procedural core	Select the possible knowledge needed to solve the student's problem.. Update other known concepts and procedures that may be linked to unknown ones. Find strategy(ies) for connecting known and unknown concepts and procedures.
Solving the student problem	Apply the strategy or strategies to relate known and unknown knowledge. Determine the knowledge desired and/or the objective
Analyzing the student problem solution	Verify that the solution corresponds to the objective and conditions of the student's problem.. Verify if there are other ways to solve the student's problem based on the known updated with the unknown. Analyze the possibility of reformulating the student problem by modifying objectives, data, conditions, strategies, etc..

Source: Modified Mendoza and Delgado (2020, 2021)

Currently, the research group is working on developing a problem-solving teaching method as a teaching methodology, adding Majmutov's Problem-Based Teaching to the Galperin-Talízina Teaching System through student problem solving.

The Galperin-Talízina-Majmutov System allows the teaching and learning process to be organized around problem solving as a teaching methodology, following the following didactic principles: a) Student Problem Situations Activity as the focus of the teaching and learning process; b) diagnosis of Student Problem Situations Activity; c) selection of a system of tasks with a problem-solving character according to Majmutov; d) organization of the didactic sequence according to Galperin-Talízina based on problem solving as a teaching methodology, and e) control of the assimilation process through actions and operations of Student Problem Situations Activity and correction, if necessary (MENDOZA, DELGADO; 2021, p. 239).

3 Methodology

This research is characterized as a literature review and presents data and discussions regarding the use of problem solving as a teaching strategy in mathematics education.

The selection of materials for analysis was carried out according to the following criteria:

- Monographs or dissertations written between 2012 and 2021 by members of the research group Didactics of Problem Solving in Science and Mathematics, linked to the federal and state universities of Roraima (UFRR and UERR);

- Surveys targeting elementary school students (early and late years);

- Studies conducted in the public school system: municipal, state, or federal.

The criteria were met by the studies by Feitosa (2014), Nunes Neto (2015), Chirone (2016), Diniz (2019), Araújo (2019), Souza (2020), and Magalhães (2021), as shown in Table 3:

Chart 3 – Works produced by the research group Didática da Resolução de Problemas em Ciências e Matemática- *Didactics of Problem Solving in Science and Mathematics* (UFRR e UERR)

Year of research	Researcher	Title	Target audience
2014	Soraya de Araújo Feitosa	A Atividade de Situações Problema como estratégia didática no tratamento da informação no 6º ano do ensino fundamental a partir da Teoria de Galperin	Sixth-grade elementary school students –State School System
2015	Ronaldo Nunes Neto	A Atividade de Situações Problema na aprendizagem do conteúdo de fração fundamentada na Teoria de Formação por Etapas das Ações Mentais de Galperin com os estudantes do 5º ano da Escola Municipal Laucides Inácio de Oliveira	Fifth-grade elementary school students – State School System
2016	Adriana Regina da Rocha Chirone	Aprendizagem de equações do 1º grau a partir da Atividade de Situações Problema como metodologia de ensino, fundamentada na Teoria de Formação por Etapas das Ações Mentais e dos conceitos de Galperin	Eighth-grade elementary school students – State School System
2019	Francisma de Oliveira Diniz	A Atividade de Situações Problema na aprendizagem com números inteiros nas operações aritméticas fundamentadas em Galperin e Majmutov com os estudantes de 7º ano do ensino fundamental na Escola Estadual Fernando Grangeiro	Seventh-grade elementary school students – State School System
2019	Hudson Cardoso de Araújo	Diagnóstico do nível de aprendizagem por meio da A Atividade de Situações Problema Discente no conteúdo de adição e subtração nos estudantes do 3º ano do ensino fundamental do Colégio de Aplicação/UFRR	Third-grade elementary school students – State School System
2020	Gilmara Batista de Souza	A Atividade de Situações Problema Discente na aprendizagem de adição e subtração com operações com números naturais fundamentada em Galperin e Majmutov nos	First-grade elementary school students – State School System
2021	Verônica de Oliveira Magalhães	A Atividade de Situações Problema Discente fundamentada na Teoria de Galperin, Talízina e Majmutov para formação de habilidade na resolução de problema com operações de adição e subtração nos discentes de 3º ano do ensino fundamental do CAP/UFRR	Third-grade elementary school students – Federal School System

Source: Authors

All studies focused on student learning. In this sense, the analysis is based on the strategies adopted to work on problem-solving as a teaching-learning methodology and on the results found from the teaching sequence followed in each study.

4 Results and analysis

The data analysis is organized in chronological order, as shown in Chart 01, with the exception of Araújo's work, developed in 2019, which differs from the others because, in addition to being a monograph (undergraduate thesis), it focuses on the analysis of data obtained in the diagnostic test. This is the first work to be discussed and analyzed because it presents a path for diagnostic analysis of the level of student learning, providing a basis for the starting point of teacher planning.

Initially, the results of each study are presented, and at the end, there is a discussion about the contributions of the Didactic System to mathematics learning in the Basic Education stage of Elementary School.

Araújo's (2019) research listed as its central objective *to diagnose, through the Teaching Problem Situations Activity, based on Leontiev and Galperin's Activity Theory and Majmutov's problem-based teaching, the level of learning in addition and subtraction among third-grade elementary school students at Colégio de Aplicação/UFRR*. The analysis of the diagnostic test showed that the Problem Situations Activity in Mathematics was an effective tool for assessing the students' starting level in addition and subtraction. The author of the study emphasized the importance of monitoring student development during each action of the teaching system.

The overall objective of Feitosa's (2014) study was to *'examine the learning of sixth-grade elementary school students in the Problem Situations in Information Processing (PSIP) activity based on the Theory of Stages of Mental Action Formation*'. The results showed that, with regard to the teaching sequence adopted, the research pointed to an improvement in student performance in terms of understanding basic mathematical elements and strengthening problem-solving, as well as an improvement in learning in the Information Processing Block, as they developed skills and competencies related to interpreting data in graphs and tables and arguing ideas. Among Galperin's stages, it was noted that students understood the guidelines and

participated in classes by answering questions and contributing hypotheses (GOOD), developed the activity satisfactorily (MATERIALIZED), and explained their hypotheses, arguments, and ideas in writing and/or speech (VERBALIZED). The research highlighted the need for continuity in the work to achieve more definitive results, considering that some students completed the process with regular development. In this sense, it recommended that PSIP be worked on not only in the 6th grade of elementary school but also in subsequent grades so that students can acquire greater skills and competencies and develop the ability to generalize.

The research by Nunes Neto (2015) had as its general objective “*to explain the learning process of Problem Situations Activity in Fraction content using problem solving as a teaching methodology based on the Theory of Stages of Concept Formation and Mental Actions with 5th grade elementary school students*” and highlighted in the results both the achievement of this objective and the records of the methodologically organized process supported by Galperin's cognitive theory. In general, the research showed that, among different students, the formation of concepts occurred at different levels; that is, some were only able to solve the problems with support material (materialized stage), others through thinking aloud (external verbal action stage), and a minority performed mentally with a certain degree of solidity (internal verbal action stage). Nunes Neto (2015) recommends his research to undergraduate and graduate students in education and/or science teaching, due to its implications in the school context, especially teaching as a driver of learning.

Chirone (2016) highlights as the central objective of his study “*to analyze the learning of first-degree equations based on problem-solving activities grounded in Galperin's theories of the formation of mental actions in stages, in the direction of Talízina's Study Activity and Majmutov's Problematic Teaching, of 8th grade students at the Colégio de Aplicação da Universidade Federal de Roraima*” and, in the conclusions, pointed out that, of the 25 participating students, 1 reached the 1st Stage, 7 reached the 2nd Stage, 6

reached the 3rd stage, 4 showed good development up to the 4th stage, and 7 reached the 5th stage. Based on this, the researcher highlighted the positive influence of Problem Situations Activity as a teaching methodology, as well as Galperin and Talízina's theories.

The research conducted by Diniz (2019) had as its central objective *'to analyze learning in the Problem Situations Activity with whole numbers in addition, subtraction, multiplication, and division operations, based on Galperin's Stages of Mental Action Formation Theories, Talízina's Study Activity Direction, and Majmutov's Problem-Based Teaching.* The results showed that the Didactic Sequence provides teaching contributions for teachers and learning contributions for students in the study of whole numbers involving the four arithmetic operations, to be developed from the students' starting level within the zone of proximal development. In terms of learning, the study found that most students reached Stage 2 and that most of the class would need more time to experience problem-solving activities in order to advance to the next stage—External Verbal.

Souza (2020) listed as the general objective of his study *'to analyze the contributions to learning from Student Problem Situations in operations with natural numbers based on Galperin's Theories of Stage Formation of Mental Actions and Concepts, in line with Talízina's study activity and Majmutov's Problem-Based Teaching, for 1st-year elementary school students at Jael da Silva Barradas municipal school'* and pointed out that the research met the proposed objective, showing that, at the beginning of the research, most students did not know how to perform ASPD actions and operations autonomously and, at the end, they showed more independence and evidence of reaching the Verbal/External stage. According to the data collected, the students were able to solve problems by distinguishing between addition and subtraction operations, developing one or more solution procedures, comparing the results to their daily lives, and validating their procedures (SOUZA, 2020).

Magalhães (2021) established as the general objective of her study *to analyze the contributions of the Student Problem Situations Activity based on the theory of Galperin, Talízina, and Majmutov to the development of problem-solving skills*

with addition and subtraction operations in 3rd-grade elementary school students at CAP/UFRR. It is important to note that among all the research used in the analysis, this was developed during the COVID-19 pandemic. Among the challenges pointed out by the researcher, the following stand out: the lack of face-to-face contact with the class teacher and the limitations due to the remote nature of the classes, the need to reorganize the daily study routine, and difficulties with the internet connection (optical fiber outages). The research showed that most students exhibited characteristics of the third stage of mental formation, expressing orally and/or in writing the steps taken to solve the operations. The actions were performed semi-independently (occasional requests for help), the students were able to explain how they performed the operations, and they had the autonomy to recognize their mistakes (MAGALHÃES, 2021).

Based on the analysis of the data obtained in each of the selected studies, and considering the stages of mental development that each one reached, it is possible to point out the valuable contributions of the Galperin-Talízina-Majmutov Didactic System to student learning. Among the mental stages, E2 and E3 stand out, which obtained the best results in the studies after the application of the didactic sequences. In the stage of Action Formation in material or materialized form, the active participation of students in carrying out the activities, either individually, in small groups, or with the teacher's guidance, was highlighted. With regard to the stage of External Verbal Action Formation, the ability to verbalize/explain the path taken in solving the activities was highlighted.

5 Final considerations.

In the studies that were analyzed, the teaching-learning processes were organized in the Zone of Proximal Development according to Galperin's Theory of Stages of Mental Action Formation and mediated by the teacher using the principles of Problem Situation Activity Direction in Mathematics or Student Problem Situation Activity, according to Talízina, based on potentially problematic tasks, according to Majmutov.

The investigations indicated that problem-solving in mathematics can serve as an effective teaching methodology, wherein students demonstrate progress in relation to the diagnosis. Specifically, students advanced to the third stage of mental action formation by engaging in discourse regarding their solution strategies and presenting the foundations of creativity. At this juncture, it is imperative to underscore that the formulation of pedagogical interventions must encompass not solely the logic of the content, but also an examination of the manner in which students learn and the stimulation required to facilitate their cognitive processes, problem-solving abilities, and creativity.

6 References

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