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Problem Solving: A Contextualized Approach to Teaching Mathematics

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Abstract: *The process of creating the Problem Solving Methodology has been shown to be long and full of deviations. For some time, there has been talk about its applicability, however, in those cases where it was performed, the results regarding mathematical learning were not satisfactory. In its complexity, when analyzing the main reasons that cancel the use of this methodology, it opens a gap in its study, because, as a consequence of its implementation, a considerable level of failure is observed in the cases applied. The present study proposes a discussion of the Problem-Solving Methodology about its historical context, its teacher training, its application in the school context, attitudes that do not generate results, highlighting those that exceed positive expectations, thus allowing a systematic analysis of the problem by understanding what is shaping the school curriculum in the process of teaching math learning.*

Keywords: *Problem Solving; Teacher Training; Curriculum; Didactics Mathematics*

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I. Introduction

The school environment, within all the requirements imposed in Brazilian schools, suffers daily with a frustrating stigma of failure, due to the high failure rates in mathematics. Whether it is the environment in a Municipal, State or Federal School of Basic Education, daily deals with the demotivation generated by the students' lack of self-esteem in learning. The school faces a discussion between faults exchanged, transferring the responsibility of the basic formation of the student, without arriving at conclusions or solutions that result in educational improvements. On the one hand, teachers accuse students of little dedication to studies and lack of commitment. On the other, we have the school as the culprit of all the problems related to teaching. After all, what is the difficulty in solving mathematical problems in school? Are there guilty?

With these inquiries, rather than discussing and instead pointing out the culprits, we want to reflect on the school's perspective on the mathematical problem and, consequently, on its resolution process. This analysis aims to carry out a bibliographical research, in order to integrate the in - depth studies on the subject in question, from a brief historical context to the current functionality of this content in schools.

In this way, to favor the process of understanding, this article is sectioned as follows: initially the historical context of the mathematics discipline will be presented, as well as the discussion of the Problem-Solving method, followed by the teacher training approach, in which on the aspects of teacher education and their possible contributions. Afterwards, it will be approached the school context of the teacher and the student, highlighting the difficulties in applying the Problem-Solving Methodology. Finally, the article will be finalized by presenting the approach to attitudes that have not been successful in its applicability and therefore the solutions that have led to positive results.

II. Problem Solving: Historical Context

At the beginning of the 20th century, in Brazil, mathematics did not yet exist. Thus, his teaching was characterized by concepts separated from three of his branches: arithmetic, algebra and geometry, so that the students were attentive to the teacher's explanations for memorizing, writing and repeating concepts [1]. In the year 1930, the first Brazilian National Law of Education, known as the Francisco Campos Reform was created, directing and orienting education throughout the national territory and, among its attributions, agglutinated the three branches, giving rise to the mathematics discipline, as today is known. Teaching was based on intuition, gradually introducing logical reasoning, encouraging discovery rather than mechanized memorization, a principle advocated by the so-called New School Movement [2].

Like any Reform or National Law, its effectiveness was only partially effective. With regard to teaching, the valuing of intuition and discovery, it was not established, shaping in the 40s and 50s of the last century, a teaching focused on the mechanization and memorization of concepts, with rigor in the

methodological procedures of the resolution, emphasizing memorizing theorems, huge lists of exercises that did not act as a meaningful learning model.

The decade of the 60, was moved by a reformulation of concepts and international language of mathematics, movement later known like Modern Mathematics. In that emphasized the Theory of Sets and the Symbology of Mathematical Logic. In the following decade, the formality and the abstraction of concepts were evidenced as results of this implantation.

In turn, the 1980s were marked by significant transformations in Brazil, where the guidelines changed, seeking to prioritize education in a way that values and social aspects were introduced into the curriculum, improving the inexpressible learning outcomes in previous decades. But it was only with the launching of the "Agenda for Action" document in the United States of America by the National Council of Teachers of Mathematics (NCTM) that the discussion of the Mathematics Teaching process focused on the problem-solving recommendation was evidenced, as a means of reinforcing and producing meaningful and meaningful learning for all.

Polya (1978), one of the main authors of this theory, influenced the directions of mathematical education, researching and creating a new paradigm for Problem Solving. He elaborated a method that taught students to improve their procedures, thus reviving the concept of heuristics, which leads to discovery and invention, prioritizing intuitive thinking in mathematics [3].

In the 90's, the well-known Renewed Teaching arises, still trying to recover the valuation of the student's cognitive knowledge, as an attempt to correct inexpressible results in complex activities demanding critical activities, when trying to get rid of the remnants of the methodologies have left the formality impregnated in school curricula.

The problem, which is the driving force of mathematical knowledge, is the means by which its researchers create, innovate and motivate to advance frontiers and define new solutions to improve people's lives or technological processes. Problems should always address original ideas, look for what has not been investigated. The more relevant the research, the more important its resolution becomes. Great discoveries solve great problems; however, it is common to have small discoveries in solving any problem. However modest it may seem, every resolution bestows the pleasure of doubt, of unforeseen, of research, and especially of taste for triumph and discovery [4].

Thus, by avoiding a bit of the conventional pattern of problems, it is necessary to think about the structure of its resolution, addressing statements that are not so obvious and that provoke challenges, considering that the Problem Solving process is a methodological teaching tool, requiring of the student the combination of his knowledge already acquired, with the new ones that will result from his research, planning and execution of strategies for the construction of his solution. It is important to know that this is an open proposal, in which the student is free to reflect on the strategies of resolution, it is up to the teacher to mediate and enable the communication of ideas. It is an effective method to develop student reasoning and the permanent motivation for the study of mathematics.

Finally, in the current context there are several types of problems, we can classify them in:

- Recognition exercises: allow the student the recognition, identification or remembrance of a concept;
- Algorithm exercises: train an algorithm and reinforce previous knowledge;
- Standard Problems: the solution is already in the statement, only has the idea of fixing concepts;
- Problems Processes or Heuristics: have no solution in the statement, requiring the student time to think and plan their resolution;
- Application Problems: also called Situations-Problem, depict real situations of the day to day, necessitating the use of mathematics to be revolved;
- Puzzle problems: they constitute a recreational part of mathematics, whose solution depends on perceiving some logic or insight, as advocated by Gestalt theorists or Conceptual Field Theory.

Finally, it becomes interesting to work with open problems that have more than one solution, allowing executors to defend methods and results, making possible a richer learning with meaning.

III. The Methodology of Solving Problems, The Bachelor and Teacher Training

The teaching of mathematics underwent some significant changes throughout its historical process, however, without any guarantee of overcoming the difficulties faced by the students. Several factors are pointed out, in which we can highlight;

- The ingrained belief that mathematics is difficult;
- The lack of teacher didactics;
- The ever-traditionalist approach with excessive emphasis on calculation.

Teachers, almost always, when questioned about the use of problem solving in mathematics teaching, point out the most diverse considerations, thus escaping their responsibilities and making it impossible to apply

them [3]. In many cases, the blame for the student's ineffective learning rests on early-grade educators, with the discourse that they chose a course in Pedagogy because they do not like math, passing on this feeling to the student in the course of their basic education. Acting with this transfer of responsibility, the math teacher tries to take the blame for his failure to make mathematics attractive and engaging for the student [5].

Attitudes of transfer of responsibility refer to inadequate preparation of education professionals that is evident in classrooms. The lack of mastery of certain contents leads teachers to teach students inefficiently, impregnating some algebra and contextualized applications in non-contextualizable situations. It is of utmost importance to structure undergraduate courses in mathematics from a problem-solving perspective so that future teachers, when living in the classroom, can have an effective experience of mathematical knowledge.

In a way that repeats what happens in basic education, in the Brazilian historical concept, undergraduate courses in mathematics, or any other degree in the area of exact, are categorized with a strong dedication to the knowledge of the content and little knowledge of the pedagogical practice [6]. It is very important that the teacher knows the training area, the concepts, the properties and the heuristics of the theorems. However, it is equally important to know how to teach these concepts, since the pedagogical content should have a greater focus, since the training model, which we criticize, has not produced teachers prepared for the classroom.

Another aggravating factor that has greatly influenced the quality of Brazilian basic education has been the lack of time dedicated to students by teachers; fruit of a strenuous hourly load, mostly folded. When attending to his financial needs, the teacher ends up being crowded in many classroom classes, resulting directly in little time for attending the student, adequate planning and training. These factors influence and discourage teachers from using Problem Solving Methodology, thereby increasingly creating the belief that "mathematics is for the few."

Undergraduate courses should be concerned with building future teachers' ability to do didactic transposition [7]. Teachers have the ethical and moral precepts of the profession that require qualification, research, improvement and constant evolution, accompanying society, promoting a modern and modern school that serves as a real learning environment for students.

Thus, embracing the methodology of Problem Solving as a way of teaching, allows the teacher the supporting role in the teaching process, in which the student is the author of his knowledge, leaving the teacher to follow, guide and instigate the definition of strategies and resolution [8]. In order to solve problems, one only learns to solve them, following the guidance of a more experienced person, in this case the teacher, who will be the guide in the resolution heuristic, in which the student can evolve more and more in the construction of his structure.

IV. The Problem-Solving Process in The School Context

The teaching of mathematics should contemplate the main objective of developing intellectual strategies, useful procedures to satisfy social needs, enabling the agents of today to control their attitudes and collective attitudes, allowing a logical sequence construction for a society of the future [9]. Therefore, the school should be concerned with what it teaches, what it learns and its actual curriculum, which is far from the formal curriculum. For it restricts the student to the free expression of his ideas, presenting the procedures of his abstraction, demonstration, reasoning, resolution and problem-solving. It is a misunderstanding of the school, to think that only in it can be taught and learned, it must construct effective conditions and molders of knowledge and thinking. In today's society, we need citizens capable of leading processes, always ahead, facing new challenges and proposing alternative solutions to social problems.

The deprivation of autonomy has given the student a natural aversion to mathematics, resulting in a blockage in the language domain, usually due to the prevalence of the idea that calculus is the most important part of the discipline. The calculation, the machines already do it and much faster. The learner needs to understand what to do with them. This results in a decontextualized mathematics class of socio-cultural reality, as if it were a mere cut of the world in which we live, without the unity of the connection of reality with other knowledge, as the real world presents us [10]. Mathematics dissociated from reality becomes a science that is meaningless and isolated.

Using the methodology of Problem Solving allows the student a powerful and very important mechanism to produce the world's own understanding [11], giving him the opportunity to learn more meaning and meaning, surpassing the naive and fragmented vision of reality. Solving problems is a genuine trait of all people. On a daily basis, individuals do various activities that the school should use to promote their social role with greater relevance and relevance. "As a basic skill, Problem Solving should be understood as a minimum competence for the individual to enter the world of knowledge and work" [12]. Using problem solving to teach mathematics should be an act linked to the interferences that the medium offers and the knowledge that the student brings with it, providing a growth and adaptation of pre-established concepts.

During the learning process when students create or solve problems, many results to be found, some right and some wrong, allow the action of reflecting on the errors, providing both growth and discuss the correctness, so that we should build moments of reflection [12].

What is relevant in group socialization is the possibility of confronting different worldviews, which allows a considerable growth for all involved, since one does not have a knowledge of one, but of the collective, which is larger and more rooted in contexts.

The construction in the school of an environment in which the student can effectively communicate their knowledge, from their searches, a culture of motivation is created of authorship of the own learning, providing a reading of world and society, that feeds the will and the interests. Understanding meaning and meaning become the main objectives of teaching, not passing on and memorizing information. During the school life, he, having had contact with these methodological procedures, will be able to act with naturalness and intelligence in face of problems of daily life, of political, economic and social order.

The Problem-Solving Methodology is also very efficient when used as a tool to evaluate student learning, because in it the student promotes strategies of resolution, argumentation and description of the same, besides providing enrichment with the group work, in a way that concepts of various individuals converge towards the construction of collective concepts.

Finally, another relevant factor in society is the use of technologies. Society as a whole has strongly embraced the technological era, since it facilitates life and social interaction intensely. However, when it comes to the use of technologies within the school, great has been the resistance of traditional and outdated pedagogical conceptions [13]. Therefore, in today's complex technological society, in the world of sophisticated calculators, computers, and automation of household goods, mathematics has a much greater role to play than merely to train calculations, "young people, appropriating technologies, using them intensely, building new forms of expression and language "[14]. It takes a more contemporary mathematical knowledge that understands the global process of change and is able to infer in it with autonomy and extended vision.

V. Problem-Solving Methodology Practice

Even when problem solving is used, it is possible to observe growing school failure. This is because there is a confusion between problem solving and teaching with problem solving. Mathematical problems are being worked in the classroom as a contextualized exercise of an activity already applied, that is, as exercises of application [15]. This generates inefficient learning, which does not reflect the ideology of problem solving. It is perceptible through the reflection of the experiences, that what happens is a memorization of the reflection and experience of another person. Often, even when the teacher chooses to solve a problem, anxious to get the result in due time, he ends up providing the answer to the student, contradicting all the precepts of solving and learning with the search for the solution.

Contrary to what is proposed with the problem-solving process, the use of exercises ends up configuring a student training activity, in which it seeks to memorize a procedure already presented by those who have already solved it, in which it is considered as correct. The problem-solving proposal is that it develops its procedure, socializes with another person, can evaluate the applicability or not, adopting another technique or synthesizing others to its own so that it best applies to the strategy [16].

However, what has often happened is the teaching of concepts and, soon after, the use of problems to fix and apply the concepts worked. This method does not constitute teaching by solving problems, but only an exercise applied to an already developed concept. This has proved to be inefficient within mathematical learning, since knowing mathematical concepts does not necessarily mean having mathematical functional thinking or mathematical knowledge about human activities.

It is also noted that the use of paradidate texts on mathematics has been very restricted. There are books, magazines and newspaper texts, presenting several motivational problems that have prompted great mathematicians to propose strategies and solutions that are impacting society, usually largely unknown to students. Thus, it is recommended to put the student in contact with these materials, so that they perceive the social relation of mathematics with the world, not leaving it as a mere academic fruit of school domain.

The choice of teaching using the Problem-Solving Methodology brings with it a series of considerations that cannot be ignored. Every problem should offer a different situation from what has already been worked on, but that uses techniques of resolutions already known; non-routine actions should be proposed, so as not to induce the student to demotivate, and to induce them to confront strategies in solving problems that do not follow the automatic school standard.

Therefore, the problem should not be treated as an isolated case within a process, but something that is not known and desired to know, using resolutive strategies and, consequently, its application, seeking to be successful at the end of the process. Thus, the focus and value of the correct answer give way to the process and strategies of resolution developed by the students.

The main objective of mathematics was to enable the student to solve problems of practical life. Starting from this principle, it is necessary to create means so that it can use the acquired knowledge, generalizing inferences in the social and professional life. It is important to highlight that, when proposing and discussing the use of problems, problem solving as a teaching methodology is not only a goal proposition to be achieved, but the preparation and training of the student to confront the attributions of his social life.

It is known that one learns to solve problems, solving them. From this perspective, over time, in the use of this practice we will have great contributions to the students and the school. For this reason, it is important to consider once again the importance of newspapers and magazines as sources of research and elaboration of the problems, since they contextualize and make real the challenges for students. The profile of the student to be trained should be considered in order to provide a better orientation of the sources to be researched, the types of problems and the context that apply; the problem solving allows to work the same concept in several contexts, allowing a contextualized approach in various situations.

Teaching mathematics from problems and resolution separate from reality, becomes incoherent, meaningless and meaningful to students. Contextualizing it has to be an objective that the teacher must take and the flexibility of the content to be approached must be dialogued with the school curriculum, adapted to the type of training profile that one wishes to offer.

There are several researches on teaching and the methodologies to be used, but they lack a discussion as to what to teach. The research on the contents that must make up the teaching matrices is as important as the teaching methodology. Soaked curricula generate so many negative results as a poor methodology [17]. One does not change the teaching of mathematics from one day to the next, one must discuss and plan in the medium and long term, involving and listening to all the people who are directly or indirectly connected to the school, so that they can construct a solid and effective transformation. However, it is essential to develop a road map, a plan with well-defined objectives to achieve a significant development in the application of the methodology in the classroom.

A care that must be taken, for example, during the execution of the resolution by the student is the adoption of observation, monitoring and evaluation of the process, paying special attention to the choice of hypotheses and strategies, to carefully carry out the interferences, comments and observations, without influencing students' decision making, characterizing an induction or manipulation of their reflective thinking. It is also important that the student, when he or she has taken a wrong choice of reflection, reaches this conclusion alone when socializing with the other classmates, once the learning effect with the recognition of the error becomes greater when guided by the process of communicating ideas. Thus, both the error and the correctness, will provide the student, learning and growth in academic life, as well as in the professional career. Therefore, great attention must be paid at this stage, because it is at this moment of socialization that most of the learning happens. At this moment personal concepts become collective and the various solutions are validated or modified within a collective thought. At this moment the teacher should only take part, highlighting the main points and concepts involved in the problem resolution and communication process.

Finally, they must also be included in the planning, problems that allow more of an interpretation and solution, so that when reviewing and socializing the solutions, realize that the solutions used for certain situations are sometimes just a logical variation of an author's interpretation to the question, and therefore, there may be other interpretations, making knowledge as something alive, which shapes and modifies according to the life story of each subject involved [18].

VI. Conclusion

At the end of this study, it is important to point out that the importance of adopting the Problem-Solving Methodology as an effective instrument in the mathematics teaching process was emphasized, since it has significant effects on student learning by providing an exchange of knowledge between educating, teacher and colleagues.

However, the methodology must be thought and planned in a way that is contrary to the one that has been developed, so that the experimentation of success, besides satisfying the longings of the learning process, overcome phobias and nullities in relation to mathematical knowledge, common among the students. It is necessary to break with the old logic of introducing concepts and then apply problems to fix them. We urgently need to introduce problem models, to get students to draw up the strategies and eventually have the opportunity to communicate the results. For, in this way, the teacher values and legitimizes the students' mental logical processes, while promoting the construction of the knowledge involved through the practice of dialogue and interaction. Thus, it is believed that these processes are promoters of both the student's autonomy and the autonomy of the teacher.

With the use of information technology, it is possible to enjoy a medium that promotes favorable conditions for efficient learning, due to the practicality and feasibility of searching for concepts and modeling information, allowing a real view of what happens in the world, using it in learning. Society has changed and the

school must face these changes, being the main part of promoting innovation. It will only be possible to achieve this independence and status when giving students autonomy in their creative and learning process. Creative people tend to build creative worlds, people who work in groups, tend to produce for the group and respect opinions, seeking alternatives that come from balancing the various concepts at stake, collectively coming to a common denominator, where more learn and consequently be transformed.

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