Chapter 52

Experimental activities: possibilities for learning in mathematics classes

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ABSTRACT
The possibilities for the newly graduated teacher are vast and attractive, when this teacher is finally linked to an educational institution it is expected that he/she can develop his/her work in a satisfactory and meaningful way with the students. From this perspective, this article presents a possibility to differentiate their planning by inserting conceptions that encompass the trend of manipulative materials for teaching geometry content. And its development we point out the need for the teacher to dress the researcher's characteristic, the student's participation as a constructor agent of his knowledge, we approach the way that textbooks treat the sequence of contents, and we then present an experience report proposing the use of manipulative materials for the study of geometric contents for High School and we conclude that the students of Escola Estadual de Tempo Integral Maria da Gloria actively participate in the classes when they are put to action, once they participated in the experimental math practice classes.

Keywords: teacher, planning, geometry.

1 INTRODUCTION

The teaching and learning of mathematics are directly related to the individual's contact with mathematical knowledge. Once the scientific knowledge of mathematics is deliberately inserted into the routine of that individual (being in class), many doubts will arise on his part about how and when this knowledge will be useful in his life, thus bringing to the classroom a materialistic approach to the contents can make most of the doubts about its usefulness to be understood, with the possibility that the students learn the contents more quickly with direct contact.

Approaching geometry in the classroom using tangible material devices can facilitate the understanding and learning of some contents by the students, which in turn can also facilitate the teacher's work when teaching these contents. Another factor that influences/facilitates is that "geometrically" speaking, the materials to be used in classes are easily accessible, low cost, simple to handle, and may be available in schools since their use will depend only on the teacher's planning.

For this reason, we aim to investigate student learning during experimental mathematics practice classes, using manipulative materials as part of the classroom teaching materials and putting into discussion the mathematics involved in the development of content worked in classes.

In the development of research regarding the teaching of Mathematics applied to practice, there is this statement by LORENZATO apud JANUARIO, (2010) that says:

> school favors the construction of a false conception of Mathematics, teaching excessively arithmetic content, without explaining the "whys" to those who want to learn with meaning, or showing what is being studied.(LORENZATO apud JANUÁRIO, 2010, p. two)

Observing this statement, it was necessary to include justifications for the study of geometry, therefore, the manipulation of concrete subjects, combined with the knowledge that the student brings in his luggage and the relationship of the contents with objects and actions of everyday life culminated in the need to carry out practical classes experiments in mathematics.

Through the construction of geometric figures, which occurs during the classes of experimental practices carried out, aiming to better understand how develops students' learning through the use of material examples of mathematical content explored by geometry in the classroom.

The present work has as its object of study the classes of experimental mathematics practices developed at the Escola Estadual Girassol de Tempo Integral Maria da Glória in the second semester of 2019, the school is located in the municipality of Tupirama in the interior of Tocantins.

2 JUSTIFICATION

In the course of everyday Mathematics classes, the idea came to approach some content from the geometry part using manipulative materials, aiming at the quick understanding of the content by the students and the good development of their learning.

From this point of reflection, I began to observe the development of students on the content taught before and after the practical classes, their participation in mathematics classes was notorious for the applications of the planning of differentiated classes. The quest to develop good student learning and to cover teaching didactics led me to develop research that would bring to planning important contributions from scholars who aim to maintain the education system, at that time it was known in the writings of Demo (2011) the importance of the teacher dressing up as a researcher.

Still in this research, I was able to observe how necessary it is to vary the way of approaching the contents since it is important to understand that the participation of the students reacts to the way the teacher teaches. Later this factor will be developed under the arguments of researchers dedicated to understanding the teacher's relationship with the students, VIGOTISKI for example, justifies that the relationship between human beings and between beings and the environment is mediated by instruments, at this point, we unite affirmations of LIMA by designating manipulable materials in the teaching of Mathematics as such mediators.

Observing the performance of the research carried out, it became necessary for students to be inserted in scientific contexts so that these contexts influenced the learning of geometry contents. Thus, the idea arose to carry out a different model of practical classes with students, where they are instructed to act in groups, working with materials that, during the classes, will assume physical forms similar to the content studied, thus presenting the abstract properties of mathematics that high school sophomores are expected to learn.

Initially, I found some obstacles in this way of working, as the parallel conversations of the students made it difficult for the classes to go smoothly and others did not give due value to the practical classes. However, with a certain insistence and differentiated routine, I could see that the students' involvement was increasing and they demonstrated ease in understanding the content in the way it was being addressed in the classes. Therefore, it is quite justifiable to seek new mathematical approaches that favor student learning.

3 TEACH MATHEMATICS

At the university, when we are in the process of higher education, we are guided to always be looking for educational methodologies that can help our work. We must be attentive to the needs of students and their disabilities in development as well as in learning. They give us access to the most diverse teaching models, they open our horizons so that we can do any type and approach of content in the classroom.

However, when we reached the dream degree and got in touch with the reality of basic education, we realized that the difficulties encountered are different (and more complicated) than what we were prepared to encounter. For the author of this writing, it was no different, when starting my professional career in teaching, I came across students with the most diverse difficulties, the most comprehensive of which is the difficulty in understanding the abstraction of mathematical content and its applicability in everyday life (SILVA and COSTA, 2016).

As the school year had already started, there was not enough time to carry out a plan in which I could take ownership of didactics that favored both my development as a teacher and the student's learning. In this way, I started teaching activities using a traditional approach to mathematics content.

Observing that the students presented old and common learning difficulties, I chose to dedicate myself to research parallel to teaching activities that could guide me to improve my work. This action was guided by an important statement by DEMO where he says:

> The "professor" (with quotation marks), to become a PROFESSOR (without quotation marks and with capital letters), needs to invest in the researcher's attitude and, therefore, pursue appropriate strategies. Above all, it must be part of their professional condition without further ado, to undo the burden of the lowly "teacher" (DEMO, 2011, p. 87).

However, it is worth mentioning that the professional aspect is in its initial phase, considering that this is my first contact with the educational reality of being on the professional staff of an institution since the taste for research comes from my recent graduation period. According to the documents that govern the teaching of mathematics, the contents that were planned for the following weeks of classes originated from Spatial Geometry, therefore, how could I approach geometry contents that could be significantly used and understood by the students? And what would this approach look like if textbooks were straightforward in their entirety, showing formulas and leading to calculations? Research could be an answer.

Historically, geometry assumes a notoriously important place in the communicative development of humanity, great names such as Thales of Miletus and Euclid and Hippocrates already elucidated geometric knowledge and relationships with astrology, etc. (TROIAN, SANTOS, and LIMA 2015).

Later, in ancient Egypt, geometry ruled writing, architecture, and astrological knowledge. Today, geometric figures are part of the logos of large companies, they are in architecture and urbanism in different parts of all cities, and products and services provided today sometimes demonstrate that geometry is a fundamental part of their structure (BRASIL, 2001, p. 55).

Thus, there was a need to show students the importance of geometry in their daily lives, since:

> Spatial Geometry presents itself as one of the essential contents of Mathematics and is characterized as of great importance for students, due to its high applicability in the most diverse areas of knowledge and everyday life. Thus, its importance in teaching for the construction of the knowledge base is clear (GRILLO, 2014. P. 27).

Based on this statement by GRILLO, we sought to find a way to approach concepts of Spatial Geometry so that students could learn and appropriate these contents to better develop their learning. In this sense, the idea of working geometric mathematics with classes of experimental practices arose, since the teacher is still in the process of searching for a professional profile that can allow discoveries and achievements, but that favors the student in the best possible way: learning mathematics.

In the intention of carrying out an experimental practice with the students aiming at their learning, we found in CABRAL and GAZIRE a statement that brought us the importance that the student's prior knowledge has, because:

> Difficulties in geometric teaching and learning are not restricted only to the complexity of the subject (its postulates and theorems), but also reside in the fact that the cognitive aspects involved in this construction process cannot be generated only from the mathematical definition. There are some geometric aspects that, to be understood, need to follow a path through which the previous experiences lived by an individual will build conceptual structures, which can help in this development. (CABRAL and GAZIRE, 2019, P.3)

Prior knowledge! For success in the development of content, it was necessary to value prior knowledge. But that's good, using what the students already know, which is from their daily lives and they understand their usefulness, makes the abstract concepts of geometry be built faster by their cognitive system.

CABRAL and BOLDRINI continue their discussion by stating that this prior knowledge existing in the student, serves as a foundation for mathematical concepts to be built, since the combination of different contexts (and here the student's baggage fits) builds the students' learning, leading to thus to its development.

> In this sense, we understand that, when teaching Geometry, one must include the possibility of incorporating different contexts into this knowledge. Considering that geometric concepts are formed by the student's interiorized action, by the meaning they give to the formulations they enunciate, and by the verifications, they carry out, we understand that the use of experimental testing activities is important in the construction of this thought, as they open paths for investigation and the development of logical reasoning. (CABRAL and GAZIRE, 2019, P.3).

It is observed that experimental activities are identified as an important factor for student learning, in fact, in the geometric context of teaching we have a notorious gap in the student learning abstract concepts of geometry. Other factors that influence the final result of students' knowledge are:

> The traditional conception that Mathematics is an exact, formal, and abstract science, leads to an ahistorical teaching practice, dissociated from reality. Their knowledge is considered cumulative and the presentation of a concept or property is justified by the need for it in the sequence of contents. It is also conceived that mathematical learning is obtained naturally through the reproduction of the above and in this way the student demonstrates that he has learned the content if he can reproduce it correctly. (HIRATSUKA, 2006, p.57).

This reproduction of the content by the student demonstrates that the teaching of mathematics is limited to the creation of copiers, which are not taught, just mechanized for a series of mass reproduction of contents. It is necessary to change this conception, for this reason, teaching geometry to students so that they feel attracted to participate in classes is a fundamental part of teaching mathematics Lima (2018).

As much as the didactic sequence structuring of which contents should be addressed and the order of these contents are very much guided in the teaching of mathematics by the guiding documents of education, the approach to these contents becomes free for the teacher to choose, in the context in question, to teach geometry, an approach with mediating instruments could be used that would make the teacher-student relationship more pleasant and thus both the development of one and the learning of the other would benefit.

The mediation mentioned above comes from a Vygotskian conception that says that "The relationship of man with the world is not a direct relationship, as it is mediated by means, which constitute the "auxiliary tools" of human activity" (VIGOTSKI apud REGO apud LIMA, 2018 P 17). Therefore, it is up to the teacher to look for mediators who can help their work with the students, making their dialogue appropriately constructive, and facilitating the students' understanding of the content being studied at that moment.

Last but not least, when analyzing the textbooks used by the Teaching Institution in question, as shown in the 2nd figure of the next topic, I observed that they approached geometry in a very compiled way, bringing the concept, content, way how develops mathematically and following that came a list of exercises for the student to show that he learned content by reproducing it.

4 DEVELOPING EXPERIMENTAL PRACTICE CLASSES

In the search for a differentiated approach to geometry content for high school, we chose to do it in the most playful way possible. Analyzing the mathematical concepts of geometric figures and geometric solids that should be studied, we noticed the possibility of presenting these contents through the manipulation of materials that could incorporate the mathematical properties that should be learned by the students.

In this way, there was a search for these manipulable and playful materials that would help in the classes. It is worth noting that RIBERIO, in the writings of BOTAS and MOREIRA cited by LIMA on manipulable, states that:

> ‘ Manipulable material' is any concrete object that incorporates mathematical concepts, appeals to different senses, and can be touched, moved, rearranged, and manipulated by children. It also adds that 'didactic material' is any resource used in the classroom to promote learning (RIBEIRO apud BOTAS & MOREIRA apud LIMA, 2018 p.17).

It is seen in this statement that there is extreme freedom in the selection of materials that could be used in mathematics classes. As for playful materials, we have

> The ludic activity is the first way that the child finds to discover the world, after all, he is not born knowing how to play or play, he learns with the mother and the family members as they use the ludic activity as a support for the physical development and the baby's mental constructs. Usually, the first ludic activities of babies are characterized by the repetition of actions just for pleasure. It is from this first contact with the ludic that reasoning begins to be generated, and its continuous use promotes the expansion of knowledge (SOUZA apud GUMIERI and TREVISO, 2016, p.71).

To elucidate this statement, we found that "thinking play as one of the most important learning tools in childhood and as the main means of integration and socialization of the child is extremely relevant, especially for those interested in the process of child development" GUMIERI and TREVISO, 2016, p.71).

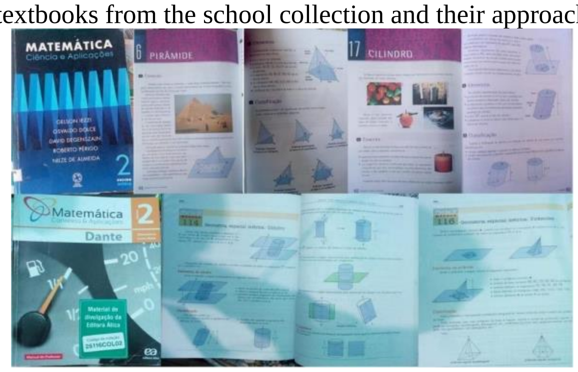
So, because they are easy to access and acquire, low-cost materials were chosen that can even be recycled, some donated by the school, others presented by the students themselves, and still others that were bought by the teacher because they are low-cost and easy to find: wooden sticks, adhesive tape, glue, hot glue, cardboard, scissors and stilettos, and rubber/slingshot alloys, as seen in the image below.

Figure 1: Manipulable materials for experimental practice classes.

For the development of content in mathematics classes, we brought a didactic sequence that first focused on knowing the students' level of knowledge about figures and geometric solids. We noticed that most students have basic knowledge of geometric figures, such as knowing the names and basic properties of some figures. They were also questioned about the applicability of the figures known to them in their day-to-day life, many responded by showing examples of geometric application in the construction of the classroom itself, in the school premises, such as the courtyard, the sports court, etc.

Until then, the development of the class went as planned, later we started the mathematical analysis of these figures from the same methodological point of view, resolution, and theorems, as they are found in the textbooks available at the school, both those used in the school year and in the books of the school collection, however, as we will see in the figures below, the books are succinct and direct, which again distanced students from their participation in classes.

Figure 2: Mathematics textbooks from the school collection and their approaches to geometry content.



In the figure above, it can be seen that the books bring the content design, followed by its elements and classifications, and on the following pages, they bring exercises to be answered by the students. In this way, we end up returning to what was said before, which DEMO argues as:

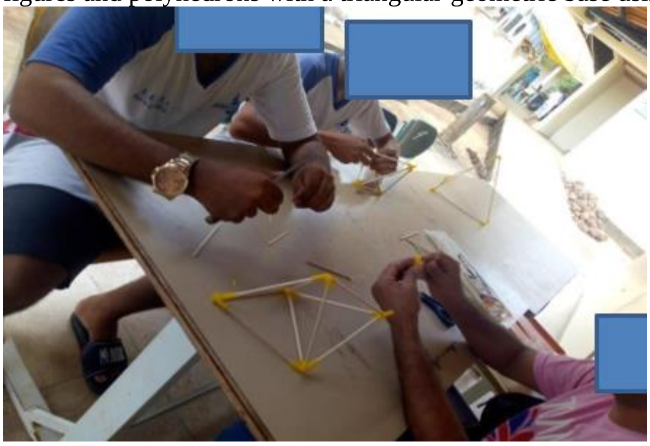
> It is important to stress the need for constant updating, which is part of research as a daily questioning, intending to avoid the instructor who spends his whole life saying the same thing over and over again, contrary to scientific progress, which means double precariousness: just copying, and spank the copy. (DEMO apud LIMA, 2018, p. 18).

To direct us towards a constant update, we return to the point where the experimental practices class began, the students were introduced to the contents from the questions about their daily life, as it had been written before; subsequently, they were led to build their geometric knowledge through practical examples of what was studied.

The experimental practice classes consisted of using tangible materials to build objects that incorporate the studied geometric properties. At that moment, a slight increase in student participation could be noticed, questioning, arguing, and placing themselves, in the words of LIMA "as participants in the process of developing their own learning" (LIMA, 2018, P.19). During the classes, when they were presented with the manipulable materials and saw them associated with the contents, the students finally began to act actively in the classes, taking initiatives for the development of the classes in a productive way, therefore, they began to manipulate the materials with geometric properties being evidenced and studied by the students at all times.

As the classes took place, the students showed themselves to be more and more interested, they were able to understand the abstract properties of the mathematical objects studied there and thus assimilate the content to knowledge, its application, and necessity. As can be seen in the figures below, the students actively participated in the experimental practice classes. The photographed solids were constructed using skewer sticks and rubber bands on the ends to fix the skewers and shape the polishers.

Figure 3: Construction of figures and polyhedrons with a triangular geometric base using manipulable materials.



From the geometric part of the triangle, the historical aspects, their properties, theorems, and specificities such as types of triangles, sides, angles, etc., were worked on in class. We also discussed why the triangular figure is often used in the construction of bridges and roofs of houses, most of the students, after making pyramids and triangles and studying them in textbooks, answered that this happens because the triangular figure is the more difficult to be deformed, being rigid and supporting actions of gravity and weight of other objects.

Figures 4 (A and B): Construction of cylindrical geometric solids.

In the figures above, the students build cylindrical shapes with manipulable materials, in this part of the experimental practice classes, these cylinders were produced with sheets of paleo and Durex tape. We lead students to learn the abstract properties of cylindrical and circular geometry, such as radius, diameter, base, and volume as well as generatrix, etc. subsequently, the students demonstrated an understanding of the applicability of the cylindrical shape in everyday life, by associating the properties of this structure with water consumption, cooking gas storage and even medicine containers.

Finally, when we returned to solving exercises, students demonstrated greater mastery in solving these exercises, more appropriate articulation when answering mathematical problems that require argumentation, and, from a quantitative point of view, increased average individual score (from each student) and also the average of the class as a whole.

5 FINAL CONSIDERATIONS

The activities carried out in the classroom must be guided by pedagogical plans that value the teacher's freedom to choose which materials he can work with to better develop his students' learning. that including during the classes the previous knowledge that the students have makes the students feel more comfortable in answering the teacher's questions For the students in the second year of high school, the classes of experimental practices were extremely important because when they were instigated to manipulate the materials and observe the abstract properties of the contents, creating a tangible form, they were able to better understand what was being studied, thus developing a better mastery of solving exercises and improving their ability to argue in solving contextualized problems.

During the practical classes, there was a significant advance in the teaching/learning of the students, noting that they had better understood the content through them, that working using an approach with manipulable materials made the students participate more actively in the classes, observing, asking, collaborating and building their knowledge, associating what was covered in class with their day-to-day situations.

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