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AN APPROACH TO THE PLANE GEOMETRY TEACHING IN THE INCLUSIVE SCHOOL CONTEXT: A DEAFBLINDNESS STUDENT CASE

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Abstract:
This article is part of a master's research developed about Mathematics teaching and the inclusion of students with deafblindness in the regular education. The research took place as a result of discussions in the Inclusive Education research group, that belongs to the Paraná Federal Technological University, Ponta Grossa *campus*, and it intended to develop teaching strategies in which all the students, with or without disabilities, used the same material and developed activities regarding the Plane Geometry concepts, effecting, thus, the school inclusion in Mathematics teaching. The research presents a qualitative and quantitative approach, using the case study as a strategy, and was carried out with eleven students of a 9th grade class from a Paraná interior state school, in which there was one student with deafblindness. The participants answered a pre-test, with conceptual questions related to the Plane Geometry and, posteriorly, there was a pedagogical intervention based on the Historical-Cultural Theory, approaching mathematical concepts using adapted manipulatives, giving opportunities to all students to elaborate these concepts. The next step was the post-test application in order to measure the appropriation of concepts by the students. In the test application and pedagogical intervention, the participants were filmed and the recordings were transcribed. The results indicate that teaching strategies with well-defined objectives contribute to the students, with or without disabilities, to develop mathematical concepts.

Keywords: special education, deafblindness, mathematics teaching

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1. Introduction

School inclusion is an educational policy that provides all people with disabilities the opportunity to attend the same schools as the others and to take ownership of the same school knowledge. However, the teaching conditions to what those individuals are subjected are questioned. In order for inclusion to take place, it is necessary to reorganize the school as a whole, from the people who attend it, from the common environments to the students, to the teaching strategies used by the teachers, so that the target audience of the Special Education, i.e. those with disabilities, global developmental disorder and high skills/giftedness, can appropriate school knowledge. Among people with disabilities are the ones with deafblindness, the focus of this paper.

Deafblindness is considered a unique deficiency; the person affected by it may have impaired vision and hearing at different levels. Its classification depends on whether or not a language was acquired, which is then called pre-linguistic or post-linguistic deafblindness. In pre-linguistic, the person did not acquire any language, and in post-linguistic, there is the appropriation of at least one language, oral or sign language. One of the main causes of post-linguistic deafblindness is Usher's syndrome, which originates from recessive genes, in which the child is born deaf and has gradual loss of vision throughout life, may have visual residues or become completely blind (Nascimento and Costa, 2010).

When it comes to teaching of these people, to be characterized as inclusive, methodological referrals in the classroom sought be sought so all can learn. In this sense, in this text we discuss aspects related to the teaching of Mathematic, more specifically on plane geometry. In this teaching, aiming to meet some difficulties that may arise, it is possible to use materials to assist students to "visualize" mathematics, valuing the concrete, so they can abstract and generalize mathematical knowledge, making them interesting and thus improving the acceptance of the subject and its teaching and learning conditions, especially in the case of students with disabilities.

All the students need to be directed towards the appropriation of knowledge, being necessary to look for learning possibilities of school content. It is noteworthy that when teaching strategies and appropriate materials are used, students can develop higher psychological functions such as language, logical reasoning, attention, concentration, perception, memory and others, as pointed out by Vygotsky (1998).

In this way, when teaching mathematics to a person with deafblindness, it is possible to develop their higher functions, and this teaching should always be made effective through mediation, by signs or instrument, but one wonders: The manipulated materials, as mediating tools, can contribute to learning Plane Geometry concepts by regular education students with deafblindness? To answer this question, teaching strategies are developed in which all students, disabled or not, use the same material and develop the same activities that address the concepts of plane geometry, thereby making effective school inclusion in the teaching of Mathematics.

In the search for teaching strategies that contribute to the learning of students with deafblindness, some activities that make use of Plane Geometrics adapted teaching materials were selected and also to analyze the application of the contributions these activities d d in preparing these concepts for the student with deafblindness.

Searching for teaching strategies that contribute to the learning of deafblind students, it was selected some activities that use adapted teaching materials of Plane Geometrics and that also analyze contributions to the implementation of these activities in the development of these concepts of a deafblind student.

2. Method

The developed research fits the descriptive qualitative approach characterized as a case study. The teaching strategies were developed in a 9th grade class of a state school in the state of Paraná.

2.1 Research Participants

Eleven students from a class of the 9th grade of a Paraná state school are considered the participants of this research, with parental consent, as requested by the Ethics Committee. The group was chosen because one of its students was diagnosed with deafblindness, presenting bilateral sensorineural deep hearing loss. According to a medical report and information obtained from the pedagogical coordination of the school, and the teacher who accompanies the multifunctional resource room, the student is diagnosed with Usher Syndrome, Retinitis Pigmentosa, Hypermetropic Astigmatism and loss of peripheral visual field.

Lack of peripheral vision does not allow the student to see things besides, above, and below her central vision. The student is fluent in Libras, is attended by classroom teachers, by the teacher interpreter of Libras and by the teacher responsible for the multifunctional resources room. For their better performance, curricular adaptations are required, such as allowing more time for the activities to be carried out, exploring the use of images and contextualizing the contents, always starting with Libras and expanding the material to be used, written in Arial size 17 font as well as the use of contrasting colors in the activity materials.

2.2 Data collection

The data collection began with the application of tests, divided into two stages, called pre-test and post-test. Pre-test was used to identify which was the spontaneous knowledge of Plane Geometry of the deafblind student. The test was also applied to the other students in the class, since one of the objectives is the interaction between them.

After the pre-test and the analysis of its results, it was carried out the development of the activities of the pedagogical intervention with the use of manipulatives to address concepts of Plane Geometry. At the end of the activities, after the use of the prepared material, the post-test was applied to verify the obtained results, which aims to measure the evolution of the participants regarding the appropriation of Plane Geometry knowledge, more especially the appropriation by the deafblind student.

2.3 Procedures

One of the main factors for learning to occur is social interaction, which contributes to the development of people, providing the formation of new concepts, as well as the improvement of existing knowledge, especially when it comes to the teaching of students with disabilities.

The formation of concepts was part of one of the studies of the Russian Piotr Yakovlevich Galperin, who was a collaborator of Vygotsky, emphasizing that the bases of the mental actions of the students need to be well organized so that the formation of the concepts happens. The internalization of actions is conceived as a learning cycle, formed by steps considered non-linear. Thus, it is emphasized in this study the establishment of guiding basis for action, called OBA (Orienting *base* of an *action)*, which according Viginheski (2014, p.44)

> *"[...] it constitutes the visualization of the action of the individual, the design of the action, the image of the final product; it refers to the procedures and system of the conditions required for the action. It involves guidance, execution, and control. It must guarantee students' understanding (meaning) and motivation (reason) for the construction of the learning object and promote the student's conscious reflection in the process.*

There are three types of OBAs that stand out among the eight ones studied in Teori of the Galperin (2009c), being OBA I, OBA II and OBA III. OBA I is characterized by the limited transfer of knowledge, with incomplete guidance, omitting some important information, making learning slow and error-prone. In the OBA II, the orientation is complete, being given all the necessary information, but its negative point is that both orientation and information are limited, being useful only for that activity, and cannot be generalized. The OBA III is characterized by the generalized orientations and information received by the student, being applied to a set of tasks, and this acts independently, as well as making few mistakes and establishing relationships with other situations. These three steps stand out because they are the ones that identify the knowledge elaborated in the daily life, the mediation and the mental action, being these the fundamental processes for the appropriation of the knowledge.

Galperin (2009a) emphasizes that guidance and execution are the two main steps so that the internalization of the external actions in internal can take place. This process, accoarding to Nuñes and Pacheco (1998), takes place from the transformation of external actions into internal ones, and this happens by changing the social experience into individual experience, which occurs when the child can assimilate proper mental actions, occurring learning and the development of skills.

For the purpose of internalization of actions and the appropriation of Plane Geometry concepts by the students, some activities that have suffered necessary adaptations were selected, minimizing some difficulties presented by C student. The student activities were distributed as described in Table 1.

Activities	Concepts Addressed	Goals	Didactic resources
01 - Activity with regular and irregular flat figures.	Nomenclature and Properties of some flat figures.	- Recognize flat figures and calculate their area. - Split the figures into smaller pieces. - Differentiate the figures, understanding their properties.	- Figures made of cardboard, such as squares and rectangles of various sizes. - Irregular figures also made of cardboard paper. - Notebook, pencil, eraser and ruler.
02 - Activity with Boxes	Area and Volume	- Calculate the volume of a spatial form. - Plan the spatial form. - Calculate the area of this spatial form.	- Boxes of various sizes. - Notebook, pencil, eraser and ruler.
03 - Assembly of geometric figures using a puzzle	Properties of Some Flat Figures and Angles	- Recall the properties of some geometric figures - Assemble geometric figures from the properties studied. - Identify the angles of plane figures.	- Puzzle with 5 pieces (RÊGO and RÊGO, 2000)
04 - Geometric demonstration of the Pythagorean Theorem	Classification of Triangles, Legs and Hypotenuse and Pythagorean theorem	- Understand the concepts of catheters and hypotenuse - Geometrically represent the Pythagorean Theorem	- Puzzle with 6 pieces, 5 of the same color and 1 of a different color (RGO and RÊGO, 2000)
05 - Activity with Tangram	Area, sides, diagonal, angle and midpoint. R recognition of flat figures	- Discuss concepts such as sides, diagonal, angle and midpoint. - Classify the formed parts, for the sides and the angles.	- Square of 20 cm of side, made of EVA. - Notebook, pencil, eraser and ruler.
06 - Activity with the Geoplane	Area and Perimeter. Symmetry, angles. Height of the figures	- Present the Geoplane to the students. - Differentiate concept of area and perimeter. - Calculate the area and the perimeter of the formed figures. - Discuss the concepts of symmetry, area, perimeter, angles, height of the figures and diagonal.	- Geoplane - Rubber (elastic)
07 - Activity with circles	Length of circumference, diameter and radius.	- Differentiate circles and circumference. - Discuss concepts such as radius, diameter and length of the circumference. - Calculate the length of the circumference, as well as the radius and diameter measurements. - Calculate the value of π based on the given circumference.	- EVA Circles - Paper strips - Calculator and / or cell phone - Notebook, pencil and eraser.

Table 1: Selected activities for pedagogical intervention
Source: Prepared by the Researcher

For the execution of the lesson plans, some activities were based on Rêgo and Rêgo (2000), such as activities 3 and 4, and others are part of the didactic collection of the researcher. During the development of the activities, it was taken into consideration the concepts in which the students presented greater difficulties, according to the results of the initial test. Some pieces of the material used were also made with texture to facilitate the identification of each activity.

2.4 Development of activities and adaptations in materials

When discussing the formation of concepts, Talizina (2009) states that it is necessary to establish a starting point, emphasizing that previous knowledge and skills are essential for the concepts to be properly formed by students. Therefore, it was proposed a pre-test with 13 questions based on the concepts to be addressed in the classroom, in order to verify that the spontaneous knowledge of the student with deafblindness had regarding the Plane Geometry content.

The pre-test was answered by 11 students whose parents authorized the analysis of their data, according to the Free and Informed Consent Form, following guidelines of the Ethics Committee. Those tests were analyzed and it was stated that a good part of the students presented difficulties in the majority of the questions, except for two, that were able to answer correctly to all the questions.

To answer the pre-test, some students used common sense terms, which highlights that the mistakes made are not only made by the student with deafblindness and that it is not only the deficiency that is hindering the appropriation of knowledge, since some students have been unable to answer any questions. Thus, some activities have been selected and adapted for subsequent application aiming the appropriation of the Plance Geometry concepts and the consolidation of existing concepts.

The students were separated into groups, with 3 or 4 students each. The activities were developed using manipulatives, defined by Nacarato (2005, p.3) as "*objects or things that the student is able to feel, touch, manipulate and move. They can be real objects that have day-to-day application or they can be objects that are used to represent an idea.*" So, it was asked the students to put away their notebooks, which caused some astonishment, and some even questioned how they were going to have math class without the notebook. This possibly demonstrates that there are many written activities and that materials are rarely used. The non-elaboration of concepts may also be tied to this fact.

Some of the materials used were adapted to the needs of the student with deafblindness, even adapted; the materials were also used by the whole class, with no distinction between the activities or the materials used by students with or without disabilities.

For activity 1, figures made in vibrant colors, such as the puzzles used in activities 3 and 4, were used, and in activity 4 a different color piece was adapted, being a rectangle triangle that will serve as the basis for the geometric representation of the Pythagorean theorem. In activity 5, a square made in EVA, also in vibrant color, was used for the construction of the Tangram by the students, as well as the circles used in the activity 7.

These activities made the students participate not only in the development of classes but also in the elaboration of some materials, reinforcing the teachings of Nascimento (2006) that emphasized that when the deafblind student participates with the teacher in the elaboration of the activities and in the elaboration of the material that will be used, it is narrowing the bonds of interaction and trust, which makes the teaching and learning process more productive and meaningful; the author further emphasizes that the teacher should carry out the activities with the child and not for the child .

Maia, Araóz and Ikonomidis (2010), when quoting teaching strategies, alert to the way each student learns, this being the orientation for class planning. When this information and experience is available, more functional activities can be developed, with the involvement of all students and resources that can be adapted whenever necessary.

When it is observed the individuality of the students as to how to learn, activities that increase the interest and participation of all can be developed, what Maia, Araoz and Ikonomidis (2010) report being a way so that the differences of each are minimized in the process of teaching and learning, enabling mutual aid and better comprehension of the limitations of each student.

3. Results and Discussion

When considering the 11 respondents who took to the classroom the authorization for participation in the research, the maximum correct answers possible was 143 (one hundred and forty-three), as there were 13 questions regarding Plane Geometry. The pre-test resulted in a total of 77 (seventy-seven) questions answered correctly, representing nearly 54% right answers, being seven (7) correct responses from student with deafblindess and seventy (70) from the other students.

Based on the results obtained in the pre-test, it was possible to verify that the students had difficulties in the concepts of area, properties of the figures, their classifications and angles. In order to overcome these difficulties, activities were developed with adapted manipulatives that approached these concepts.

In activity 1, which aimed for the students' correct identification of plane figures and their properties, some figures made out of cardboard were handed out ot them (Figure 1), so that they could be classified as to the sides and the angles.

After identifying each figure, the students were asked to calculate the area of each of them using only a ruler and a pencil, without the use of the calculator. Initially, no formula for the area calculation was discussed, since these contents had already been worked on by the class teacher on other occasions, and was based on OBA I, which consists of an incomplete orientation, referring to a particular situation, which can lead to difficulties and a greater number of errors.

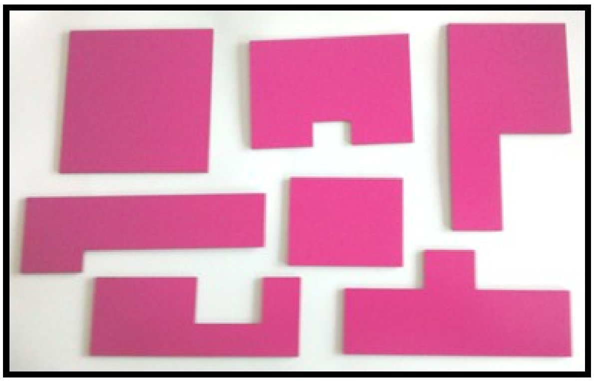

Figure 1: Regular and irregular shapes
(Source: Researcher's collection)

Some difficulties still came up with respect to formulas and mathematical operations required to calculate the area. As the difficulty in this activity was collective, some questions were made to the students and were passed some guidelines in order to generate a discussion with colleagues from the group about the correct formula to be applied, enforcing OBA II, with a guidance that included the activity carried out at the time, not being possible to generalize.

The students still had difficulties, demonstrating that they had not assimilated the concept of area, which is why OBA III was applied, which consists of giving the students the opportunity to construct their concepts with the help of teacher and colleagues. Talizina (2009) reports that the formation of concepts is linked to actions, and that without them the concept may not be assimilated. In this respect, Vygotsky (1998) states the concepts are developed through many different interactions and become scientific concepts at school with the help of the teacher.

With the actions and discussions held, the students presented a gradual development in the organization of their thoughts, which may have contributed to the expansion of their zone of proximal development.

When working the area calculation, it was verified the difficulty of the students on the area definition. Talizina (2009, p.271), when discussing the role of concept definition in the process of assimilation, exposes that "*este trabajo real sobre la valoración de diferentes objetos, gradualmente creael concepto adecuado em la cabeza del alumno como imagem abstracta y generalizada de los objetos de la classe dada*"[ii].

Acquiring the definition does not mean that the concept has been assimilated, that is the beginning of a process. Later, we need to include the concept in school actions performed with objects similar to initially discussed, so to help in the construction of the concepts of these objects (Talizina, 2009). To do so, activities were proposed with irregular figures, in which students should calculate separately the areas of figures worked on previously to get to the answer of the area of the given figure.

[ii] "*this real work on the valuation of different objects gradually creates the appropriate concept in the student's head as an abstract and generalized image of the objects of the given class*" (Translated by the authors).

The student C, with deafblindness, when calculating the area of the irregular figures, did some inadequate procedures, which originated in a wrong result for the area of certain irregular figure. Therefore, an intervention became necessary, which helped the student to identify inadequate procedures that she had performed and, from there, to reach the correct result.

Activity 2 was proposed aiming at the appropriation of the concept of area and volume, as well as its calculations and the recognition of dimensions of length, width and height. Therefore, some boxes of varied measures were used to calculate the volume. Some groups had difficulties because they did not establish the basis of the box, and as they manipulated it, they were confused by the measures they had already encountered.

In search of resolving this issue, it was discussed the number of dimensions of the plane figures, with only length and width, and then compared with the spatial figure, which has width, length and height. The orientation was based on OBA II, being valid for the activity to be developed, without generalizations. When this was exposed, the students were able to calculate the volume because they made the area of the base and located the height, arriving at the correct result, realizing that, regardless of the position of the box, the volume would be the same. Again, it was the oportunized students to build the concept, now the volume, which helped to solve the problem involved in the activity.

The student with deafblindness was able to carry out the activity, quickly identifing what could be the base of the box and then calculating its volume, showing that she comprehended and differentiated the concepts of area and volume.

Activity 3 aimed at students' appropriation of the properties of some geometric figures such as square, parallelogram and triangles, in addition to the angles in these figures. Each group received five pieces of a puzzle (Rêgo; Rêgo, 2000), consisting of a square, a trapezoid, two rectangles of different rectangles and a non-convex polygon. For the application of the activities, all the pieces were made in EVA in vibrant colors, for better use by the student with deafblindness.

Students should identify each piece that made up the puzzle and then assemble some figures like the square, parallelogram, rectangle triangle and a Greek cross, always using all the pieces of the puzzle. The identification of parts was done correctly by all students, but some had difficulties when starting the assembly, because they did not consider the properties of each figure that should be assembled, which were discussed in previous activities, requiring intervention to recall important properties.

It was verified that, with the development of the activities and with the manipulation of the pieces, the assembly of the last figures was performed in a relatively fast time when compared with the first ones. With respect to the right triangle, when asked to assemble it, the students were readily prepared to develop the activity without requiring any intervention, which shows the construction of the concept of this figure by students and that with the manipulation of different objects the students were able to gradually create a generalization of the categories studied (Talizina, 2009).

With the right triangle assembled, it was raised the question of the nomenclature of the sides of this triangle, and the students did not know how to answer. So, they were asked about the Pythagorean Theorem, and the answer was that the theorem was a2 = b2 + c2, but they could not say what that represented. Thus, activity 4 was developed, discussing the Pythagorean Theorem, its geometric representation and the nomenclature on each side of the triangle, as well as the angle that determines when the Theorem can be applied.

For activity 4, a new puzzle (Rêgo; Rêgo, 2000) was used, consisting of 5 pieces of the same color and a different color piece, which features a rectangle triangle that will serve as the basis for the geometric representation of the Pythagorean Theorem. This piece, according to Rêgo and Rêgo (2000), did not need to be of a different color, but this was done to meet the needs of the student C. With this material, the students assembled the geometric representation of the Pythagorean Theorem, creating a square with 5 pieces of the same color, using the measure of the hypotenuse of the triangle rectangle of different color. Students identified the measure as the a2, quoted at the beginning of the discussion, thus emphasizing that it was the measure of the hypotenuse of the right triangle.

Then, students should undo the square and, with the pieces, assemble other two squares with the measurements of the legs of the triangle rectangle of different color (Figure 2), which was initially identified by the students as being b2 and c2, and after the discussion it started being referred to as the legs of the rectangle triangle.

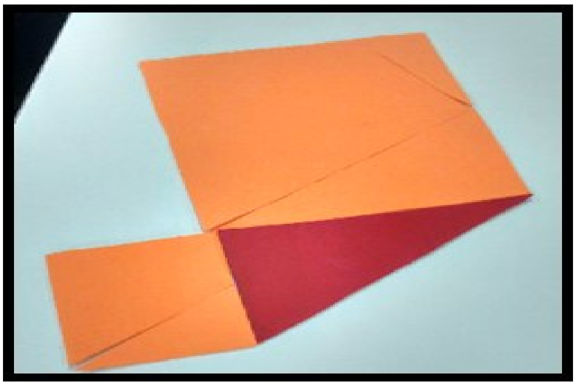

Figure 2: Puzzle geometrically representing the Pythagorean Theorem
(Source: Researcher's collection)

With this activity, it was possible to verify the students knew what the Pythagorean Theorem was about, but still could not make use of the external language, which is when the student is able to expose the understanding of the concept, demonstrating that it is still in the step defined by Galperin (2009b) as a material or materialized action, in which it is necessary to manipulate objects so that it is possible to initiate the mental plan of action, as it happened with the activity of the puzzle of the Theorem of Pythagoras.

Student C easily performed the activity, and her group ended earlier than the other groups. This is already expected, because when answering a question of the initial test the student had already identified the hypotenuse in a triangle rectangle. This activity, with the geometric representation, for the student with deafblindness with residual vision is a positive factor, since the use of touch was prioritized in order to assemble what was proposed (Nascimento, 2006).

In Activity 5 the Tangram was used, a puzzle with 7 pieces built by the students, and to do so all of them received a square with side measuring of 20 centimeters. From this square, the students were instructed to draw straight lines to form the Tangram pieces. At that moment, all concepts applied to draw these lines, such as diagonal, midpoint, parallel lines, side and angles were discussed. The student with deafblindness developed the activity well, managing to trace all the requested lines correctly.

For the development of the activity, each student had to cut out the seven pieces that were drawn in the square. After that, they were asked to rate each piece, as well as the triangles, on the angles and on the sides, in addition to naming each of the pieces.

In order to reinforce the concept of square, students were asked to assemble the square again. The difficulty found by everyone, including the student with deafblindness, was evident; some even wondered if it was really possible, despite being aware of the parts that they had were the same as outlined for them in the square initially delivered. Some of them quoted that it was necessary to remember the properties of a square, which facilitated the development of the activity, and all managed to complete it, including the student with deafblindness.

Some activities with the Tangram were applied, reinforcing the concept of area. As an example, in the activity that uses the smaller triangle as a unit area, students should form some figures with a certain area, such as a square of area two; a square of area four; a triangle of area two; a triangle of area four; a rectangle of area four; a rectangle of area six; a parallelogram of area two; a parallelogram of area four; a trapezoid of area three; and a trapeze of area four. This activity stimulated the students' logical reasoning and the exchange of information between them, since they had to assemble the figures together due to the number of pieces (Figure 3). The student with deafblindness was one of the first to complete all the figures and also helped other groups.

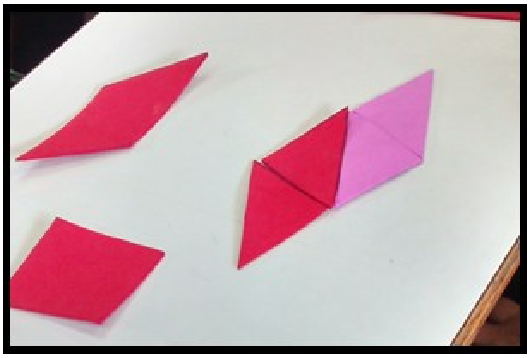

Figure 3: Area activity with Tangram parts
(Source: Researcher's collection)

The reason for the students having completed this activity more easily meets the studies of Talizina 2 (2009: 120), which states that *"... the assimilation of the knowledge introduced is characterized by the presence of multiple aspects and the possibilities of using them in solving different types of problems*". It is evident, therefore, that in the initial activities involving the concept of area, the students presented greater difficulties, significantly diminished when this concept began to be worked on several types of problems.

Continuing the work on the concept of area, activity 6 was applied with the Geoplane, defined by Menezes (2008) as a wooden plaque with a checkered mesh and with nails fixed at the vertices of this mesh, and each square formed by 4 nails representing a unit of area (Figure 4).

Figure 4: Geoplane
(Source: Researcher's collection)

Each student received a Geoplane, which generated a lot of curiosity, since many of them were not aware of this material. Given that, a brief explanation was made of its use, and elastics were handed out to the students to manipulate the material freely. After that, they were requested some activities on area and perimeter, among which students should make two different figures with area of 6 units, but made 6 unit area figures, showing that there was still confusion between the concepts of area and perimeter. It is assumed that the difficulty arose from the fact that they had never worked with the Geoplane, and because of this, the activity took a little longer to complete.

The student with deafblindness was able to develop the activities very well, showing that she understood the concepts studied, besides showing enough interest in working with the Geoplane, being always attentive to all activities and information.

The students, in general, at first, had some difficulties in the development of activities with the Geoplane. Talizina (2009, p. 117) asserts that the difficulty of solving mathematical problems is not related to mathematics itself, but to a conduction that guarantees the correct resolution of such problem, which is the understanding of the situation and of what is being requested. The author adds that during problem solving, as in the activities developed here, it is necessary to analyze the situation as a whole, not only in the mathematical aspects.

Activity 7 sought the understanding of concepts of circumference, circle, radius, diameter, circumference length, and the value of the number π. Some circles of different diameters and strips of paper were distributed to students. They were asked about the measures that could be related in these figures, and some quoted the 360° measurement, others mentioned radius, starting the discussion about the bike radius, and one student explained that it is radius because "*it goes from the center to the bicycle tire*", showing that mathematical knowledge may be related to daily facts

The concept of diameter was discussed, using circles that were given to them, to draw the radius and then the diameter, so as to verify the difference of each of the concepts. Later, the students were asked to find the length of the circumference, surrounding the circle with a strip of paper, as it was judged that the measure would be more accurate than with a string, due to its higher elasticity compared with the paper.

Thus, students rounded circumference with the paper strip and marked it with a pencil where it completed its turn around the circle, then they used a ruler used to find the measurement obtained as shown in Figure 5. Then, they measured the diameter of the same circumference and noted the measurements obtained.

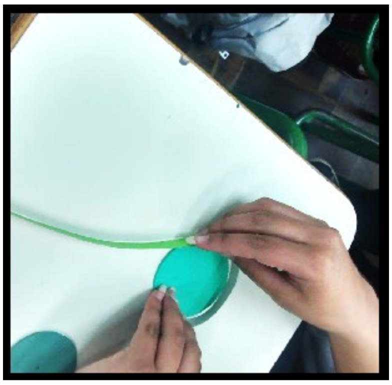

Figure 5: Calculation of the circumference length
(Source: Researcher's collection)

With the help of the calculator, or by using the cell phone, students calculated the result of dividing the circumference length by the diameter measure to find an approximation of the number π. The student with deafblindness was able to obtain the measurements correctly, as well as the value of the number π, reaching 3.11cm.

The results obtained by the students were varied, such as 3.22cm; 3.1cm; 3.16cm; 3.71cm; 3.18cm; 3.14cm; 3.16cm; among others. Given these results, the value of the number π was exposed, and discussed what is an irrational number and the reason the results obtained were not all the same. When the students became aware of the approximate value of the number, they spontaneously remeasured the diameter and length of the circumference in an attempt to get a number closer to the number, and some even managed to get a better result.

In all activities, it was evident that the use of the materials did not guarantee the immediate learning, but it is worth mentioning that these activities improved the students' participation in the classes, showing themselves interested and in search of new knowledge. It can be said that the student with deafblindness presented some difficulties, but in most of the activities she showed a lot of interest, which reflected in her performance, managing to complete all the activities and even, sometimes, helping her colleagues.

In this context, group work with the use of manipulatives favored the inclusion in school, development and learning not only of the student with deafblindness, but of all students. Another important factor is that the materials used have been adapted according to the needs of the student with deafblindness, however, its use was not restricted only to this student, but the whole class used the same adapted material.

At the end of the activities, the post-test was applied, with the same 13 questions of the pre-test, seeking to measure the evolution of the acquisition of knowledge related to Plane Geometry by the student with deafblindness.

As the questions were conceptual, the answers had to be specific, but when it was found that certain response, even if not with the properly defined concept, but made sense for student learning, it was considered correct. The student with deafblindness presented difficulties to answer some questions of the post-test, such as those involving the concepts of rectangle triangle, diameter and radius, and therefore it was suggested she drew what was necessary to represent her answer, according to Figure 6 .

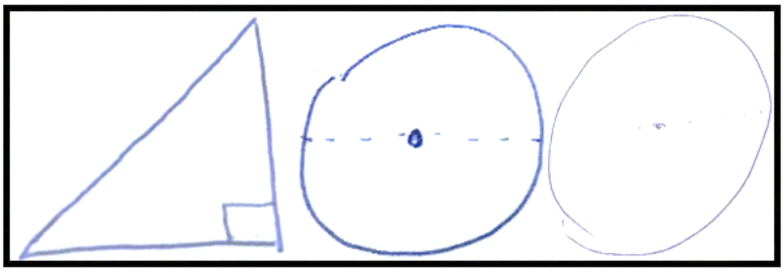

Figure 6: Student C's answer to questions 8, 10 and 11
(Source: Researcher's collection)

In the post-test, the total of correct answers that could be achieved was 143, the amount achieved was 116 (one hundred and sixteen), representing 81% accuracy From the 116 correct answers, student C, with deafblindness, correctly answered 12 questions and the other students answered 104 questions. The only question that the student with deafblindness failed to correctly answer is "what is a plane figure?", but that does not mean she did not know the concept. This fact was attributed to the difficulty in expressing such a specific concept in Libras. It is believed that the proper presentencing of the test was is there were figures of various shapes and it was asked these student to point which represented a flat figure, but, seeking to remain faithful to the pre-test, this was not done.

It was verified that all students better understood the Plane Geometry concepts, given that when comparing the pre-test and the post-test, there was an increase from 54% to 81% of right answers from all the students, and the student with deafblindness, who had answered correctly only 7 of the 13 questions, ended up answering 12 of them right, which represented an improvement from 53% to 92%, showing so a significant development in relation to the concepts of Plane Geometry.

Galperin (2009 b) states that when the application of a specific action takes place, when organized in detail, the main difficulties of many tasks are eliminated, which for the author contributes to the formation of quality mental actions for all students, increasing school achievement.

It is noteworthy that it is up to teachers to seek methodological resources for students to participate more in classes and thus be able to learn and develop. It is known that educational intervention developed with the students is just one example of how it can encourage them to solve problems, being critical and investigative. It points out that this work should not end, being necessary to the new interventions for students to really take ownership of all the concepts of Plane Geometry and other types of content that can be worked with them.

5. Final considerations

Teaching of students with disabilities, as well as the others, is a challenge when the teacher does not yet have enough knowledge to practice teaching with these students, since inclusive education aims all students, without distinction, considering that everyone has the right to education and learning. Teaching strategies should be adapted when necessary, as well as pedagogical materials, helping all students interact and be able to access the school curriculum, which is one of the ways of inclusion.

This paper has shown that students with deafblindness have some limitations, but this does not prevent them from learning and appropriating concepts taught in school. Thus, it is stated that all students, disabled or not, can take ownership of scientific knowledge, what was found in this research, because with the educational intervention, based on Galperin's (2009 b), action formation steps, students displayed a better performance over the concepts of Plane Geometry.

In response to the researcher's initial question, knowing how the use of manipulatives as mediators instruments can contribute to the learning of Plane Geometry by students with deafblindness who study in regular schools, it was verified that when the materials are adapted and applied to fill gaps in the concepts to be worked, as well as when they are planned and chosen for a specific purpose, their use can contribute to the appropriation of the knowledge of this concept and also for the teaching and learning process as a whole, because the use of these materials made the students become more reflexive and critical.

The adaptations undertaken can be related to the use of texture in the produced material, as well as the differentiation of colors, since more vibrant colors were used to facili tar manipulation of the student with deafblindess due to her visual residue. In this educational intervention, it can be infered that the use of manipulatives contributed for the acquisition of knowledge of Plane Geometry not only by the student with deafblindness, but by all participants who evolved in the process of teaching and learning, thus making all the proposed objectives achieved.

It is noteworthy that not all Plane Geometry concepts were addressed in the educational intervention applied, but what was possible to develop appeared positively both in learning and in student participation.

Some difficulties occurred on the students' side, such as group work, which was initially treated with strangeness, since the group hardly performed activities this way. Another fact that the students were not accustomed to was the lack of use of the notebook, since the main objective was to work with the manipulatives in the discussion and development of the activities. In addition, the students wanted ready-made formulas for the accomplishment of the activities, having a hard time grasping the concept that it was necessary to understand the concepts studied so they could apply it in the activity.

It is important to stress that working in groups with students with disabilities requires more effort and dedication from the teacher, since in dealing with the teaching and learning process; this is the person closest to the student with a disability. However, the teacher is not solely responsible for this process, it is necessary that all school, society and government be engaged in the real inclusion of the disabled student, and the teacher can receive Special Education guidelines so that this process can be more fruitful.

It is clear that the teaching strategies presented here are not enough to meet all the needs of students when it comes to Mathematics and even Plane Geometry, particularly students with disabilities. Other researches can be developed with the aim of narrowing the differences that occur in the process of teaching and learning, making the students with disabilities, and in the case of students with deafblindness, be stimulated and have the same opportunities as other students, improving the quality of teaching as a whole. To do so, it is important that teachers rethink their practices, because regardless of whether there are classes with students with disabilities or not, it is necessary to seek teaching strategies that provide learning for all without distinction.

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