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TEACHING ANGLES AND POLYGONS USING GEOGEBRA SOFTWARE

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ABSTRACT

The objective of this work is to describe a didactic-pedagogical sequence developed to teach angles and polygons in an 8th grade class of Elementary School of a state public school in Palmeira dos Índios, Alagoas, Brazil. The sequence is part of the Extension Project "Mathematics and Active Methods" and addresses some common difficulties in teaching geometry, such as the abstraction of formal concepts and the lack of understanding of students of the connection of these concepts with real situations. Studies indicate that the use of digital technologies facilitates visualization and interaction with mathematical concepts, promoting more dynamic and meaningful learning. In view of this, the sequence, applied in four classes, involved activities contextualized to the sport, using the GeoGebra software. The results show that, although some students still face difficulties, the interactive and contextualized approach improved engagement and understanding of formal mathematical concepts, especially geometric ones.

Keywords: Teaching and Learning. GeoGebra. Geometry. Polygons.

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INTRODUCTION

The objective of this work is to describe a didactic-pedagogical sequence developed to teach angles and polygons in an 8th grade class of Elementary School of a state public school in Palmeira dos Índios, Alagoas, Brazil. Using the GeoGebra software and applications of mathematical concepts to everyday life, the development of this didactic-pedagogical sequence was articulated with the Extension Project "Mathematics and Active Methods".

During Mathematics classes, it is noticeable that some students have difficulties in assimilating mathematical content, including in the area of Geometry. The studies carried out by Oliveira (1980) and Mizukami (1986) highlight the students' questions regarding the usefulness of mathematical concepts, which shows us the need for a differentiated approach to these concepts. Thinking about these difficulties, we propose a sequence of activities in which, using the Geogebra dynamic geometry software and starting from sports practices, we approach the concepts of angles and polygons.

The use of educational software, such as GeoGebra, has been recognized as an effective tool for teaching mathematics at various educational levels. According to Artigue (2002), the use of digital technologies in the teaching of Mathematics provides students with a more dynamic and interactive approach, allowing the exploration of concepts in a visual and practical way. In addition, as highlighted by Trouche (2004), GeoGebra also offers a learning environment that allows students to experiment, conjecture and discover mathematical properties, which contributes to the development of critical thinking and autonomy in the learning process.

By using GeoGebra in the teaching of angles and polygons, with an emphasis on the sports context, we try to promote more meaningful and contextualized learning. In this regard, Silveira and Bisognin (2008) highlight that the use of software offers many potentialities, as it allows students to explore geometric concepts in an interactive way, visualizing the relationship between angles, measurements and properties of polygons. This approach can expand the possibilities of understanding mathematical concepts, making learning more engaging and accessible to students.

Hohenwarter and Jones (2007) add that the use of this software promotes an investigative and collaborative approach, encouraging students to solve problems, communicate their ideas, and work as a team. In this line of thought, the use of GeoGebra not only facilitates the teaching of angles and polygons, but also promotes the development of essential skills, contributing to the formation of more critical citizens who are prepared for the challenges of contemporary society.

Geometry, although an essential branch of Mathematics, reveals an unsatisfactory performance among students. As observed by Tashima and Silva (2008), this specific component of Mathematics often presents results far below expectations. Given this scenario, we agree that it is necessary to plan and develop classes that alleviate the difficulties presented by students in this area.

Difficulties in teaching and learning geometry can be attributed to a number of factors, including abstraction from formal concepts and students' lack of understanding of the connection of these concepts to real situations. Agreeing with Rogenski and Pedroso (2009), we believe that students have difficulties in visualization and geometric representation and, as a result, may have a superficial and fragmented understanding of the subject.

To face these difficulties, we believe that it is crucial to adopt didactic-pedagogical practices that promote the contextualization and visualization of geometric concepts. As Silva (2014) states, it is necessary to rethink the strategies for teaching geometry in the face of profound social and technological changes.

Contextualization involves integrating geometric concepts into situations and problems in students' daily lives, making them more meaningful and understandable. For Vasconcelos (2008), contextualization is to present situations that give meaning to the concepts we want to be learned, through problematization, so that this context will give meaning to the content and lead the student to understand it. For contextualization, the use of technological tools such as GeoGebra plays an essential role in improving geometric learning. As Oliveira and Cunha (2021) point out, the use of educational software provides students with a better visualization of the content covered, in addition to leading them to think and reflect.

GeoGebra is a dynamic mathematics software that allows the interactive visualization of geometric concepts. It offers a platform where students can explore and manipulate geometric figures, perform constructions, and observe the consequences of different transformations in real-time. GeoGebra is defined by Silva (2022, p.10) as "a software that provides working with various content in the discipline of Mathematics involving different topics such as geometry, algebra, graphs, and statistics". Marchetti and Klaus (2014) highlight that the use of GeoGebra software allows the teacher to solve problems related to the students' daily lives. In this way, students have the opportunity to carry out analyses, participate in debates, reach conclusions and ask questions.

Thus, by incorporating contextualization and the use of GeoGebra in the teaching of geometry, educators have the opportunity to alleviate some of the difficulties faced by students. These approaches make learning more relevant, as well as help build a consistent understanding of geometric concepts, applicable in different contexts. We believe that adopting these strategies can lead to significant improvements in educational outcomes.

METHODOLOGY

The sequence was applied to 20 students in the 8th grade of the final years of elementary school in a state public school in Palmeira dos Índios, Alagoas State, Brazil. This sequence was carried out in four classes and divided into two parts. In the first part, the activities were related to the concept of angles and their classifications; and, in the second, held in the last two classes, we addressed the concept of polygons. For this study, Mathematics related to the sports context was worked.

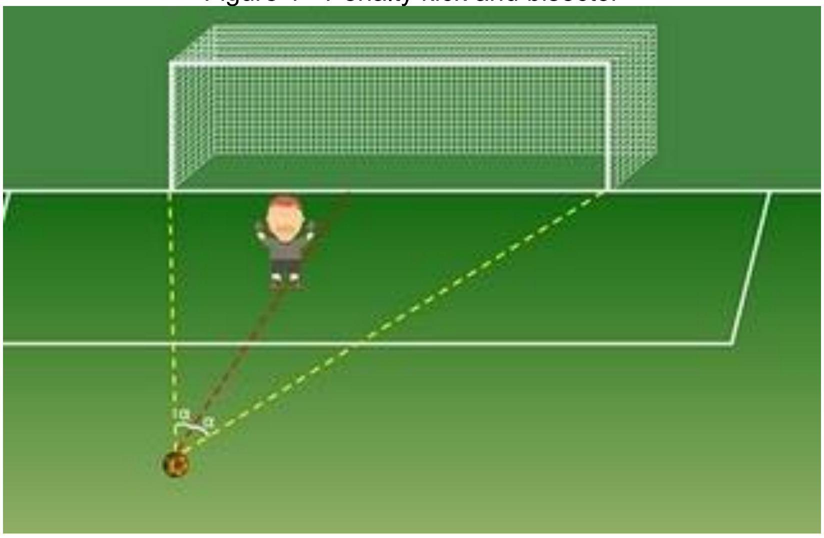
Although the students had already studied the concept of angles and their classifications, we resumed it so that they could perceive the usefulness of this context in their daily lives. For this, we use the sports context as a means to expand this understanding and the GeoGebra software, as a tool to assist and expand the possibilities of learning.

THE CONCEPT OF ANGLES AND THEIR CLASSIFICATIONS

Initially, in an attempt to engage students and introduce the topic in a contextualized way, we separated the class into groups of three students and proposed two initial challenges. The first challenge proposed consisted of an image presented to the students and they had to identify how many players were disturbing the field of vision of the referee who needed to see a certain player who was going to take a free kick, for this they needed to make use of the transferor. After a few minutes and with help, as some students did not know how to use this measuring instrument, they solved the first challenge.

The second challenge was the construction of the bisector from any angle. In this challenge they had a lot of difficulty, even though they had already studied the concept of bisector, making our intervention necessary. Thus, in addition to building several bisectors with them, step by step, we present Figure 1. In it, there is a penalty kick that explains how this mathematical concept is present in everyday life, especially in the sports context.

Figure 1 - Penalty kick and bisector



Source: Google images, 2024

Then, we asked them at what point in football they could perceive the presence of Mathematics and, after their answers, we had a brief conversation about the connection between Mathematics and football. Aspects such as the geometry of the soccer fields, the angles of passes and shots, and the analysis of ball trajectories were highlighted. This conversation aimed to demonstrate the presence and importance of mathematical concepts in sports, making the content more relevant and interesting for students.

In order for all students to participate in the activity, as not everyone likes soccer, we included dances, artistic and rhythmic gymnastics, which for them, initially, seemed to have no connection with Mathematics. We show, therefore, how angles are fundamental for the execution of movements and choreographies, helping students to see Mathematics applied in different contexts of their daily lives.

Then, in order to review the concept of angles, once seen by the students, we included the use of the GeoGebra software. The students were instructed to use the tool to insert images of soccer matches and gymnastics presentations and, through specific commands, calculate the angles present in the figures and classify them. The introduction of the software has made it easier to view and understand the angles and their classifications. Figure 2 shows one of the images used by them and the calculation of the angles with GeoGebra.

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Figure 2 - Measuring angles in the image with GeoGebra

Source: Google Images adapted, 2024

After this activity with GeoGebra, we work with them on the internal angles of a triangle. Each group was given a sheet of paper and asked to follow the steps presented in Chart 1. The execution of this activity is shown in Figure 3.

Table 1 - Internal angles of a triangle

INTERNAL ANGLES OF A TRIANGLE
STEP 1: Cut the sheet in the shape of any triangle; STEP 2: Next, use pencils of different colors to mark the three internal angles; STEP 3: Then, cut the triangle into three parts; STEP 4: Finally, join the three vertices into a single point;

Source: authors, 2024

Figure 3 - Construction and sum of the internal angles of a triangle

Source: authors, 2024

This last activity was designed with the purpose of migrating from the content of angles to the concept of polygons. It was well accepted by the students, and they were

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surprised when they found that the sum of the measurements of the internal angles of any triangle is 180°.

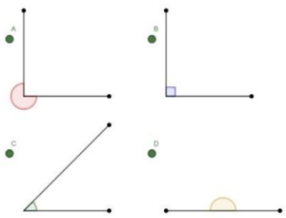
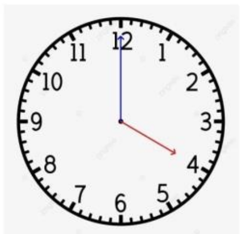
THE CONCEPT OF POLYGONS

At the beginning of the second part of the sequence, we discussed the idea of what polygons would be. After this brief discussion, we explain in a more formal way the concept of polygon and regular polygons. Relating to the concept of angles explained earlier, we show that the sum of the interior angles of any regular polygon can be obtained through the formula $S = (n - 2) \cdot 180°$. To do this, we used the decomposition of each polygon into triangles, always resuming the previous activity of proving that the internal angles of every triangle add up to 180º.

Then, we used the GeoGebra software again, to learn how to build polygons. Then, we showed them the steps for building these polygons and shared images again in the sports context, so they could identify the polygons present and calculate the angles.

To finish the didactic-pedagogical sequence, we developed a learning verification quiz. The questions included questions related to the concepts covered in the classroom and were carried out from the Plickers platform. Chart 2 presents the quiz questions.

Chart 2 - Quiz questions on the Plickers Platform

Question	Alternative
1. In which figures are the acute and obtuse angles? 	a) A and D b) B and D c) B and C d) C and A
2. What is the internal angle formed by the hands of this clock? 	a) 50° b) 80° c) 110° d) 120°

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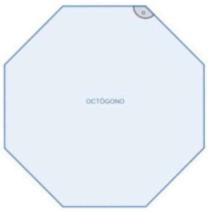
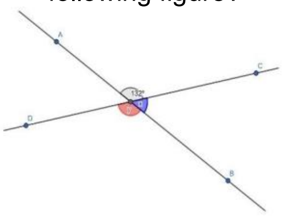
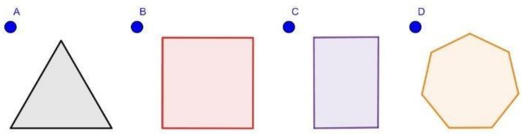
3. What is the measurement of the angle α? 	a) 120° b) 135° c) 150° d) 175°
4. What is the value of the x and y angles in the following figure? 	a) x= 96° and y= 132° b) x= 48° and y= 132° c) x= 132° and y= 46° d) x= 50° and y= 120°
5. Which of these figures is not a regular polygon? 	a) The b) B c) C d) D

Source: authors, 2024.

RESULTS AND DISCUSSIONS

From the activities carried out, we noticed the difficulty of some students in relation to the concepts worked. They said they did not remember these concepts, despite having studied them recently, which shows their difficulty in learning the concept. In this regard, Lopes (2009) highlights that the teaching of Mathematics has been characterized by repetition and memorization, preventing effective student learning.

From the beginning of the sequence, it was possible to observe the configuration of Mathematics as difficult to understand through the students' reports and the difficulties they presented to solve the proposed challenges. It should be noted that, although they had already studied the proposed concepts, some students were not even able to make a simple classification of angles.

Another factor that tends to be an obstacle and directly influences the students' non-learning is their lack of attention, since "most students do not show interest and do not give due attention to the contents and activities proposed by the teacher" (Bitencourt and Batista, 2011, p. 3). Validating the studies of these authors, we observed that there were two students who showed a profound lack of interest in participating in the proposed

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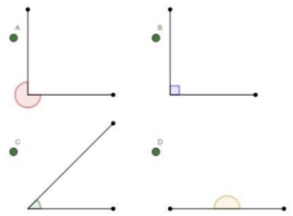
activities, spending a good part of the class talking or trying to divert the attention of the other students.

On the other hand, during the development of the sequence, two students who had been labeled as uninterested and undisciplined showed full interest in participating in the proposed activities. In addition, these two students were able to solve the challenges presented, which may be a strong indication that, by inserting software and other teaching approaches, there is greater socialization of students and consequently the expansion of the possibilities of learning the concepts worked.

In the first part of the sequence, the students had greater difficulty in solving the challenges presented, seeming to reveal that they did not know how to use the necessary measurement instruments. When we added the GeoGebra software, except for the two girls who were always talking to each other, all the students carried out the activities without much difficulty, proving their contact with technological tools. According to Prensky (2001), today's young people are called digital natives, as they grew up in the midst of technology, making daily use of technological devices such as cell phones, computers, video games and others. This fact, in our view, allowed them to carry out the activities more easily.

The first question of the quiz (Chart 3) was a multiple-choice question containing four alternatives in order to observe whether the students were able to classify the angles.

Chart 3 - Question 1 of the quiz

1. In which figures are the acute and obtuse angles? 	a) A and D b) B and D c) B and C d) C and A

Source: authors, 2024

In this question, all students had difficulty in understanding the existence of external angles, revealing that they only consider angle the internal region between two semi-straight lines that start from the same origin, a definition most presented in the teaching of Mathematics.

In the second question (Chart 4), more contextualized to daily life than the first, the students needed to remember the 360° angle applied to the 12-hour wall clock. To solve it,

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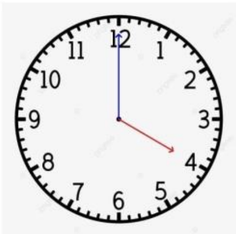
therefore, each student had to divide 360º by 12 and determine the angle formed by the hands of the clock.

Chart 4 - Question 2 of the quiz

2. What is the internal angle formed by the hands of this clock? 	a) 50° b) 80° c) 110° d) 120°

Source: authors, 2024

In this question, we observed that the number of correct answers was higher than in the previous one. And most of the students were able to respond without our help. In our view, understanding the values of angles in this context has become more significant for students than classifying angles based on their measurements.

The third question (Chart 5) aimed to calculate the measurement of the angle in a given regular polygon.

Table 5 - Question 3 of the quiz

What is the measurement of the angle α? 	a) 120° b) 135° c) 150° d) 175°

Source: authors, 2024

We noticed that they were able to respond quickly, needing only to apply the formula for the sum of internal angles of a regular polygon. All students answered, except for the two students who were calling attention during the application of the sequence.

The fourth question (Chart 6) asked the students to identify the value of the x and y angles and, for this, they needed to use the concepts of angles opposed by the vertex and supplementary angles to answer.

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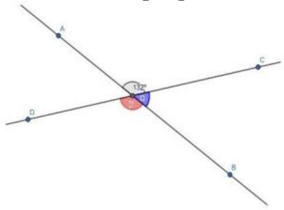
Chart 6 - Question 4 of the quiz

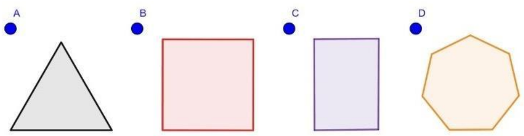
4. What is the value of the x and y angles in the following figure? 	a) x= 96° and y= 132° b) x= 48° and y= 132° c) x= 132° and y= 46° d) x= 50° and y= 120°

Source: authors, 2024

Most of them had no difficulty in answering this question, and were able to answer it in a short time.

The fifth and last question (Chart 7) was very simple, in which the students only needed to identify which polygon was not regular.

Chart 7 - Question 5 of the quiz

5. Which of these figures is not a regular polygon? 	a) The b) B c) C d) D

Source: authors, 2024

To answer this question, the students observed the characteristics of each figure, such as the measurement of the sides and needed to remember the definition of regular polygons.

CONCLUSION

The didactic sequence allowed students to perceive the practical application of angles in sports and artistic contexts, which facilitated the understanding of the concepts and expanded the possibilities of knowledge construction by the students. The use of GeoGebra proved to be effective in visualizing and handling angles, contributing to a more interactive and meaningful learning. The integration of practical challenges and contextual presentations kept students engaged and motivated throughout the activities. Despite some initial difficulties, especially in the use of instruments and in the understanding of concepts, most students showed significant progress, highlighting the importance of methodologies that integrate technology and contextualization in teaching.

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The use of sports and artistic contexts, combined with the use of technological resources such as GeoGebra, proved to be an effective strategy for teaching angles and their classifications, as it managed to keep a large part of the class engaged in carrying out the activities. The interactive and contextualized approach promoted a more relevant learning, contributing to the construction of the formal mathematical concept.

In this line of thought, it is possible to affirm that the adoption of pedagogical practices that encourage exploration and experimentation, such as those proposed in this sequence, can contribute significantly to overcoming the barriers that students face in learning Geometry. Therefore, we recommend the continuity and expansion of such approaches in the classroom, always aiming at the formation of critical citizens who are able to apply mathematical knowledge in various situations of daily life.

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