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THE USE OF THE GEOGEBRA SOFTWARE AS A TEACHING SUPPORT FOR TEACHING TILE WORKING

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Abstract: With the growing importance of Digital Information and Communication Technologies in the educational context, the use of technological tools to contextualize mathematical contents and for reflective and meaningful learning becomes essential. In this context, this study investigated the use of GeoGebra software as a didactic support to help teach tiling. The research was carried out with a second-year class of the Technical Administration course at the Federal Institute of Education, Science and Technology of Maranhão - Barra do Corda Campus, during the second half of 2022. Four moments were carried out, one theoretical in the classroom and three practical ones in the computer lab and in the school yard, with construction activities, analysis and understanding of the tiling study using the GeoGebra software. The results showed the students' interest and excitement in the proposed activities, which were able to promote a contextualized and reflective study, associating theoretical and practical teaching. In addition, the use of this technological tool can meet the individual needs of each student, making classes more dynamic and interesting.
Keywords: Mathematics, Teaching, GeoGebra, Tiling.

INTRODUCTION

With the accelerated advance of Digital Information and Communication Technologies in the educational context, teaching methodologies have undergone several rearrangements over time, especially after the pandemic period, when teaching had to be reformulated to meet current needs. In this context, several questions arose about how teaching could appropriate the advancement of technological resources. One of these questions was how to adjust teaching by articulating theory and practice with students' daily lives.

According to Silva and Correa (2014), the introduction of technologies in the educational environment can make the teaching and learning process more attractive, pleasurable, meaningful and dynamic for all involved. As an educator, I have observed over the years that the teaching of mathematics still presents many challenges, both in relation to pedagogical practices and the degree of students' learning difficulties. For many students, this discipline is still the reason for many doubts and questions, which ends up affecting the entire educational process.

As Claudio Landim, coordinator of the Brazilian Mathematical Olympiad for Public Schools (OBMEP) said, the problem in Brazil, even before the pandemic, is the lack of teacher training to teach Mathematics in Pedagogy courses. He emphasized that teachers end up teaching children what they don't know and trying to convey rules and algorithms without understanding their meaning. Over the years, this problem accumulates and many students end up reaching the end of school knowing very little about Mathematics (Revista Exame, 2021).

The use of educational technologies is essential to make teaching Mathematics more attractive and efficient, promoting reflective and meaningful learning for students. However, it is important for teachers to train and promote innovative teaching practices. In this sense, the study presented is an experience report that sought to investigate the use of GeoGebra software as a didactic support for teaching tiling in a technical high school class. The objective was to provide a solid and meaningful learning of mathematical contents through theoretical-practical classes. The project was motivated by observing the low performance of students during the pandemic and post-pandemic at the institution where the author teaches classes.

TILING

Tiling is an ancient technique that dates back thousands of years. The Egyptians were masters of the technique and used it in the construction of temples, paintings on objects, floors and walls, in addition to creating art with this technique. Precision and creativity were notable skills of this civilization. Already in the 13th, 14th and 15th centuries, the Arabs mastered the knowledge of geometric processes of symmetry and created beautiful tiling, such as those found in the Alhambra, a set of palaces in Spain built by the Moors and Christians. These geometric patterns were impressive, as can be seen in the images in figure 1.

According to Dias and Sampaio (2013, p.70):

> No artist delve as deeply into the infinitive as Maurits Cornelis Escher [1]. On his travels around the world, he discovered the Arab art of tiling, especially when he discovered the Alhambra tiles. Escher fell in love with the geometric figures that were repeated and reflected, and began to tile surfaces, replacing the geometric figures, used by the Arabs, with concrete images.

In addition to these civilizations and Escher's studies, Europe during the Middle Ages also used tiles in the construction and decoration of its churches, palaces and castles, and artists created works of art with this technique. In the 20th century, the tiling culture continued to be used all over the world, including in Brazil, in several areas, such as architecture, design, art and mathematics education. The beauty and precision of this technique continue to inspire artists and mathematicians, who explore its creative and geometric possibilities in their work.

GEOGEBRA

ABOUT GEOGEBRA

GeoGebra is software that can be used in various mathematical contexts, such as geometry, algebra, spreadsheets, graphics, statistics and calculations. It was created by the Austrian Markus Hohenwarter [2] with the objective of working on mathematics education in schools. It is an online platform that offers resources for dynamic visualization of geometric constructions, which are automatically updated whenever the user modifies one of the objects in the drawing or its algebraic representation. In addition, GeoGebra has applications that facilitate its use in the classroom.

With the software, it is possible to design geometric models in 3D graphics, which generates dynamism and awakens students' attention and involvement with the mathematical content. As Maltempi (2004, p. 267) points out, "the awakening to the development of something useful puts the learner in contact with new concepts. Mastering these concepts brings a sense of practicality and power, increasingly encouraging the search for knowledge".

TILLING WITH GEOGEBRA

In this session, we will present the practical activity that was carried out with the students in the computer lab using GeoGebra. The activity consists of building tiles from polygons. We start by checking, using the software, whether a composition (5, 5, 10) forms a semi-regular tiling. This activity was

1 Maurits Cornelis Escher (1898-1972), born in Leeuwarden, was a great Dutch graphic artist, renowned for his arts based on woodcuts, lithographs and halftones (mezzotints). Part of his art style seeks to represent "impossible" constructions, in addition to thinking about tiling the plane using "intertwined" geometric patterns, which give the eye the vision of different forms.

2 Markus Hohenwarter is a mathematician from Austria and teaches at Johannes Kepler University (JKU) Linz. He is president of the Institute of Mathematics Education and has great influence on research on DICTs in Mathematics Education. (CORDEIRO, 2014).

Figure 1. Alhambra, the hallmark of the Arab presence in Spanish history.

Source: Dias e Sampaio (2013), Book: "Desafio Geométrico - M**ódulo I**"

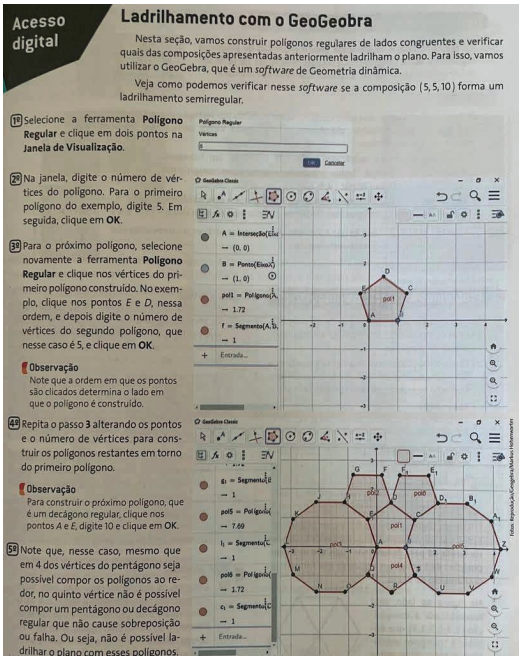

Figure 2. Proposed activity for students in the computer lab.

Source: Andrade, T. M. et al (2020), Book: "Matemática Interligada**:** 'Geometria espacial e plana**"**, p.73.

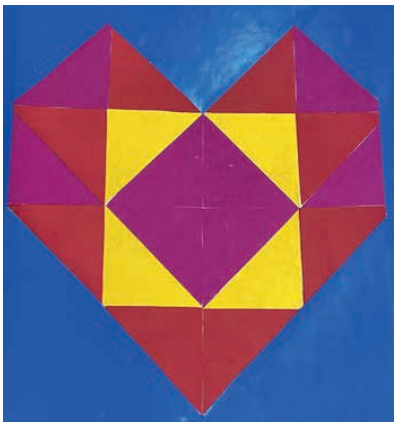

Figure 3. Tiling built with right triangles.

Source: prepared by the students of the class.

based on the didactic sequence presented by figure 2.

From this application, the students were invited to verify if the suggested composition variation also tiled in the plan. Then, students were free to build their own tiles and record their observations from the visualization in the software.

TEACHING PROJECT

This study consists of observations made during the activities developed in an applied teaching project at the Federal Institute of Education, Science and Technology of Maranhão (IFMA), Campus Barra do Corda, with students of the 2nd year of the Technical in Administration course, during the second half of 2022.

This project aimed to articulate the knowledge acquired during the theoretical and practical classes, aiming to guarantee the re-signification of the students' learning. The activities took place from September to December 2022 and were divided into four moments: theoretical class in the classroom; practical tiling construction activity with concrete material (colored cardboard, glue and scissors); experimental tiling construction activity using GeoGebra in the computer lab and exhibition and presentation of the work at the event of the National Week of Science and Technology (SNCT) at the IFMA Campus Barra do Corda.

The first moment of theoretical class, lasting two hours/class, in the classroom, topics of Plane Geometry, historical aspects of tiles, types of well-behaved tiling and their constructions were discussed.

In the second moment carried out, in two hours/class, also in the classroom, it consisted of dividing the class into two groups in which a research on well-behaved tiling was carried out. Then, an experimental activity was proposed, which consisted of the construction of regular tiling and semi-regular tiling, an activity for each group of students. During this moment, the students played an active role in the organization, execution and presentation of the constructed tiles. Figure 3 shows the construction of a tile made with triangles.

In the third moment, the students carried out the activity described in figure 2, using the GeoGebra software, in the computer lab. They made several tiling constructions and discussed the observations displayed in the software.

During the attempts to create a regular tiling, they realized from the experiments that it would not be possible to build a regular tiling using, for example, pentagon and decagon, pentagon and heptagons, as it could leave empty spaces or overlapping polygons. Then, it was proposed the creation of tiling with equal polygons and with different polygons. Some students accessed conFiguretions to color the polygons and transformed the look of their constructions, as shown in figure 4.

After completing the activities, the students pointed out that the GeoGebra software is innovative and facilitated the understanding of geometry content. And yet, some commented that teachers must use this technological resource more during classes, as it would help understanding the contents and make math classes more attractive and fun.

According to the National Curriculum Parameters (2017), moments like these aim to improve the concept and geometric visualization of mathematical contents and the use of GeoGebra software, provides greater student involvement, making classes more dynamic and learning more meaningful.

Finally, the fourth moment consisted of finalizing the project where students had the opportunity to expose and present, in the morning and afternoon, the work they developed during the classes, at the SNCT event promoted by the Barra do Corda campus

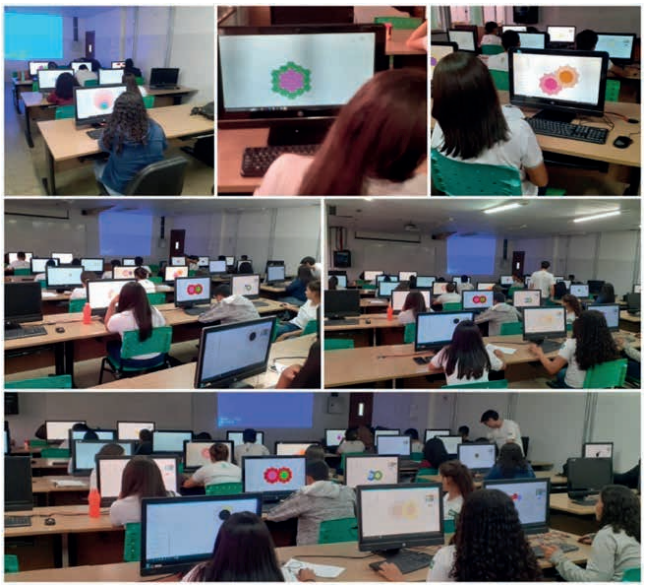

Figure 4. Tiling construction in GeoGebra

Source: author (2022)

Figure 5. Presentation of the tiling activity at SNCT.

Source: author (2022)

of IFMA, as shown in figure 5.

This moment was important, as it resulted in a great deal of learning throughout the development of the activities proposed by the project. The results presented were satisfactory, since it aroused the students' interest in the classes with the use of the technological resource. In addition, the use of GeoGebra made the classes more dynamic and interactive, which contributed to arouse students' curiosity and interest in the subject.

FINAL CONSIDERATIONS

The use of technologies such as GeoGebra in the classroom can be very beneficial for students' learning, as it allows them to visualize mathematical concepts in a more concrete and interactive way. In addition, technology can help make instruction more personalized, allowing students to progress at their own pace and receive more immediate feedback on their performance.

However, it is important to emphasize that the use of technology must not completely replace the role of the teacher in the classroom. It is essential that teachers are well prepared and qualified to use technological tools effectively and that they know how to guide their students in the learning process. The use of technology must be a complementary tool to face-to-face teaching, and not a solution to all educational problems. It is noteworthy that teachers must be mediators and students must be protagonists in the teaching-learning process.

The execution of this work aimed to disseminate the importance of using technological resources in educational practice, as the adaptation of classes with the use of technology provides dynamic, reflective and meaningful learning. It is hoped that actions like these can be replicated in order to reframe teaching, providing more creative and innovative classes that arouse the interest of students.

THANKS

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