The teaching of trigonometry using the *Geogebra* software as a teaching - Learning tool

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ABSTRACT

Researches have been revealing the great technological advancement and its potential in all fields and how its use can cause good results in the educational area. It is noted that technology is a great ally of all people and one of the points highlighted in this work is the use of technological means to use them as tools in the teaching-learning process. Therefore, this research was developed as an alternative for the teaching of Trigonometric Functions, specifically Sine and Cosine, using a free software to improve the graphic visualization of the functions, the understanding and the interest of students in the subject. This computational resource provides students and teachers with another environment in which learning can be stimulated, through the union of computer resources directed to the teaching of mathematics. Thus, this work aims to analyze how much Geogebra can contribute to the teaching of trigonometric functions, exploring their variations in relation to the resources that the software has. The work was developed in two classes of the second year of high school at the Federal Institute of Northern Minas Gerais, Salinas Campus. In the research, activities were developed on the variations of the sine and cosine functions. One class developed the activities using only basic school materials for mathematical study and in the other, the Geogebra software was used as a tool, in order to improve visualization and understand variations. The results of the activities revealed that the Geogebra software presents itself as an important educational tool in the visualization, understanding of the elements, concepts and their variations. Therefore, this teaching methodology presented us with the benefits of the technique in favor of mathematics education, using a specific software to contribute to the student teaching-learning process.

Keywords: Teaching-Learning, Trigonometric Functions, Geogebra, Tool.

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INTRODUCTION

Trigonometry arose with the idea of associating shadows cast by a vertical rod with hours of the day: sundials, called gnomon, a name given by the Greeks, according to the historian Herodotus (490 – 420 BC), Souza (2014). Figure 1 shows a sundial still in use in the fifteenth century

Figure 1: Fifteenth-century sundial

Source: Photo taken at the Epic of the Discovery in Porto Seguro – Bahia – Brazil

Today we can describe several applications for trigonometry, such as: satellites, astronomy, aviation, engineering, physics, medicine, topography, geography and many other areas. Trigonometry is a part of mathematics that works with triangles, circles, waves, and oscillations.

This work was conceived as a proposal to improve the teaching-learning of trigonometry, specifically of the trigonometric functions sine and cosine; using an *Educational Software*: *Geogebra*.

With so many applications in everyday life and in the face of the difficulties presented by most of the students, it is intended to work in a differentiated way the concepts of the trigonometric cycle, the elements of the sine and cosine functions and to understand the variations in the parameters of these functions. Pedroso (2012) in his studies reports that during his teaching activities he perceived many difficulties in the learning of his students in relation to this theme, both in the meanings of the contents developed and in the symbolic language. These difficulties were perceived by both high school and undergraduate students, they see trigonometry as a difficult, meaningless content and are unaware of its applications.

This proposal was developed in two classes of the 2nd year of High School at the Federal Institute of Science and Technology of Northern Minas Gerais – IFNMG – Salinas Campus. The research consists of using *Geogebra as an* auxiliary tool in the teaching of the aforementioned functions in order to improve the visualization and perceive the variations in them. Initially, the approach to the content was worked in a traditional way using only the blackboard with the classes and later the activities were applied and the results were compared. In one class, the questionnaires and activities were answered in the classroom without any assistance, and in the other, the software was used as a tool to improve the visualization and understanding of the concepts and graphic variations.

In view of these difficulties, *Geogebra was used* as a tool that helps in the visualization and, consequently, in the understanding of this content.

According to the National Curriculum Parameters for High School (PCNEM) – it is necessary to differentiate in the methodologies used in the classroom to obtain scientific-technological learning in High School.

Moran, Masetto and Behrens (2000) state that we learn better when we experience, experience, feel, relate and establish bonds, which strengthens the need to implement differentiated methodologies that involve students more. The use of computers is closely associated with the daily lives of today's young people, who see themselves in a highly interactive and dynamic environment.

The educational mathematical software chosen was *Geogebra*, which according to Pedroso (2012), is a program that allows you to study Algebra and Geometry at the same time.

Brasil (2000) states that trigonometric knowledge is related to the development of skills and competencies as long as its study is linked to applications, avoiding the excessive algebraic calculation of identities and equations. Therefore, emphasize the important aspects of Trigonometric Functions and the analysis of their graphs, skills that can be achieved through the use of computer tools.

Trigonometric Functions are linked to many phenomena in our daily lives, especially those of a periodic and oscillatory nature.Thus, it intends to explore and deepen the variation of the parameters of the sine and cosine functions, since in the applications the functions are modified in all their parameters, and it is important that the student understands their behavior in practice. As an example of the variations, in the textbook Marmo (2008), the author addresses the representation of the Periodic Functions in pulmonary respiration in cyclical processes of inspiration and expiration, where each complete cycle lasts 5 seconds and is described as a function of time as: volume total do ar, (1) $V(t) = \frac{3}{2\pi}[1 - \cos(0{,}4\pi t)]$ com in seconds and the $t \geq 0$airflow, (2) $F(t) = 0{,}6sen(0{,}4\pi t)$ with.$t \geq 0$

Araújo and Nóbrega (2010) add that the use of *software* is not based on a definitive solution of mathematics teaching problems, as well as Trigonometric Functions, but seen as a didactic strategy that mediates the teaching process. The use of the computer as a mere digital notebook does not provide an opportunity for the exploration of mathematical contents. Based on these conceptions, it is necessary to rethink pedagogical strategies in order to effect some change.

Reflecting on the difficulties presented and how to work differently using computer tools in mathematics, the following research problems were formulated: What contributions can the use of *Geogebra* add to the teaching-learning of the Sine and Cosine Functions? And how can we use these tools to improve the learning of these Functions?

In an attempt to present an alternative to such questions, this research has general objectives, to analyze the use of *the Geogebra software* as an auxiliary tool in the teaching-learning process, in classes of the 2nd year of High School at IFNMG – Salinas Campus, in activities involving the Trigonometric Functions: Sine and Cosine.

The Specific Objectives are:

i. To analyze the difficulties encountered by high school students in solving trigonometry problems;
ii. Develop activities with the use of *Geogebra* that help students to know the important elements of Trigonometric Functions and their variations;
iii. Evaluate the use of technological resources in the teaching-learning process, comparing it with traditional teaching in an attempt to improve it; and
iv. Explore the peculiarities of Trigonometric Functions in a critical and investigative way.

Therefore, this work aims to verify if the good development of the student is linked to the use of innovative actions combined with conventional materials: board, chalk, pencil, paper, among others. Associating the use of computers with Mathematics classes can be a great alternative with a diversified methodology. By itself, this practice is not effective, it is necessary for the student-teacher interaction, as well as for the teacher to adapt to the use of new computer techniques.

THEORETICAL BACKGROUND

The national curriculum parameters for secondary education highlight the importance of studying mathematics in a contextualized way, emphasizing its applications, as the text emphasizes:

> The objectives of High School in each area of knowledge should involve, in a combined way, the development of practical, contextualized knowledge that responds to the needs of contemporary life, and the development of broader and more abstract knowledge, which corresponds to a general culture and a worldview. (Brazil, 2000, p6)

The PCNEM also emphasize the need to modify the way mathematics is presented and taught, emphasizing the use of technological resources for greater learning of the discipline.

> This impact of technology, whose most relevant instrument today is the computer, will require a redirection from the teaching of Mathematics under a curricular perspective that favors the development of skills and procedures with which the individual can recognize and orient himself in this world of knowledge in constant movement. (Brazil, 2000, p 41)

According to the PCNEM, the purposes of teaching Mathematics at the high school level indicate as objectives to lead the student to: understand the concepts, apply their mathematical knowledge to different situations, analyze and value information from different sources, using mathematical tools to form their own opinion that allows them to express themselves critically about Mathematics problems, express themselves orally, written and graphic in mathematical situations and value the precision of language, establish connections between different mathematical topics and recognize equivalent representations of the same concept. (Brazil, 2000)

Specifically on trigonometric functions, the PCNEM emphasize the importance of examples applied for a greater understanding, as in the text:

> Another theme that exemplifies the relationship between the learning of Mathematics and the development of skills and competencies is Trigonometry, as long as its study is linked to applications, avoiding excessive investment in the algebraic calculation of identities and equations to emphasize the important aspects of trigonometric functions and the analysis of their graphs. Especially for the individual who will not continue his studies in the so-called exact careers, what must be ensured are the applications of Trigonometry in the resolution of problems involving measurements, especially the calculation of inaccessible distances, and in the construction of models that correspond to periodic phenomena. In this sense, a project also involving Physics can be a great opportunity for significant learning. (Brazil, 2000, p 44)

Thus, it can be highlighted that the importance of differentiated classes with technological resources, contextualized examples, applications in other disciplines and in mathematics itself facilitate student learning and participation.

According to Bonfim (2013), the use of technologies is welcome in the teaching of Mathematics, through programs and *software* that help in the understanding of the contents and in the desire to learn mathematics more and more, to learn how to do mathematics. It also highlights that the use of *software* is an innovative practice that instigates in students an interest in the construction of knowledge, since the computer is part of everyone's daily life. The use of these facilitates the performance of activities that have a higher degree of difficulty.

Bonfim (2013) points out that when using the *software* , a better knowledge of the content is observed by the students, because it is a differentiated class that arouses greater interest. The activities carried out with the help of technologies are most of the time interpreted correctly and when typing a wrong number in the desired function, soon the students realize the flaw, they know how to extract the information from the statement and interpret the plotted graph.

Souza (2014) points out that the computer and its applications today represent a new way of looking at education. New communication technologies are increasingly being incorporated into student life. Thus, it is necessary for the teacher to have a minimum of technological knowledge and a lot of pedagogical knowledge to integrate these new resources satisfactorily into their course program.

Periscano (2013) also points out that the use of *educational software* aims to demonstrate that the use of new technologies within the classroom makes classes much more interesting for students, the contents are better understood and the main objective is achieved, which is the teaching and learning process. In addition, it shows the student that the content studied has a practical application and that the use of this content by the student in his routine life will depend on what professional activity he will follow.

It can also be highlighted that in the use of *educational software* in mathematics classes, specifically in trigonometric functions sine and cosine, they have a more efficient learning and a better visualization of the graphs and their variation in the Cartesian axis, as highlighted by Pedroso (2012), in the results obtained using the Geogebra software, using a The teaching sequence provided students with the manipulation of figures, the observation of variations and properties of constructions. This dynamism and interactivity provided significant learning, as the group moved from the posture of listening to explanations to the posture of hypothesis investigator.

The use of computational resources in the classroom is not in itself the mechanism that will lead students to learning, but a tool that will help the teacher in the teaching-learning process, as highlighted by the authors Araújo and Nóbrega (2010). The use of *computational software* is not a tool that will definitively solve the problems of teaching mathematics, as well as Trigonometric Functions, but it is seen as a didactic strategy that mediates the teaching process.

Thus, it can be emphasized that the good development of student learning is linked both to flexibility and to innovative actions with conventional materials: blackboard, chalk, etc. Adhering to the use of *educational software* in mathematics classes can be a good alternative of diversified methodology. However, it is emphasized again that this practice is not enough for the student to learn, it is necessary for the student-teacher interaction, as well as the constant updating of the educator to the use of new technologies applied to mathematics.

The software chosen for this research was *Geogebra. Free educational software* , of Dynamic Geometry, created in 2001, at the American University Florida Atlantic, by Markus Hohenwarter, to be used in the classroom. With this computational resource, it is possible to work on the teaching of Mathematics from Elementary School to Higher Education. According to Persicano (2013), it is a program that is easily accessible and continuously updated.

With *Geogebra*, Bittencourt (2012) points out, it is possible to work with Algebra, Geometry and Calculus. Constructions can be made with points, vectors, segments, lines and conic sections, as well as functions; You can also modify these entities dynamically. On the other hand, equations and coordinates can be entered directly.

The *Geogebra* interface features an algebraic window and a graphical window, in which the Geometry tools can be operated by means of the mouse to create geometric constructions on the sketchpad. Silva and Penteado (2013) state that the program has two working windows: geometric and algebra. The geometric window is the place where the objects are constructed. In it, it is possible to color figures, increase the thickness of lines, measure angles and distances, enable Cartesian coordinates, polar coordinates, etc. In the Algebra window, you can view the algebraic representation of every constructed object. This double representation of objects is the most notable feature that the program has.

Finally, among the various uses of *Geogebra* , it can be highlighted that in the teaching of trigonometric functions, specifically: sine and cosine, it allows a better visualization and dynamism in the work with such content, especially when there is variation of its parameters. Thus, this computational resource provides students and teachers with another environment in which learning can be stimulated, through the union of computer resources directed to the teaching of mathematics.

METHODOLOGY

The research has a quantitative-qualitative character, in this approach there is an organization of the data so that the researcher can make decisions and draw conclusions from them. According to Terence and Filho (2006), this approach is concerned with measuring quantity, frequency and intensity; and analyzing the causal relationships between the variables that were applied in the treatment of the questionnaires, where the students were accounted for, their interest in mathematics, use of information technology, etc.

Subsequently, the qualitative approach was used, where Gil (2002) assures that it is an organization of the data in such a way that the researcher can make decisions and draw conclusions from them. In view of the measurement of the students' profile, the results obtained were compared with the proposed sequence, and thus, the results of the research involved were obtained.

The modality was action research. In action research, in addition to understanding, it aims to intervene in the situation. Researchers and participants are involved in a cooperative and participatory way.

According to Fiorentine and Lorenzato (2009), in action research, the researcher inserts himself in the environment to be analyzed in order to study it, understand it and, above all, change it in the direction of improving practices.

The research was carried out at IFNMG – Salinas Campus. The classes chosen to carry out the research are two, of the six, from the 2nd year of High School. These classes were chosen because they were in the classes in which the research professor taught his classes.

In the research, trigonometry activities were developed. In class – Class A: 26 students – developed using the *Geogebra software* as a tool to improve visualization and understand variations and in the other – Class B: 35 students – worked in a traditional way: using pencil, eraser, ruler, calculator, etc. It is noteworthy that, before developing the work in the two classes, the content proposed in this research was worked in a traditional way, at the same time and using the same methodology. After this development, the activities were applied and worked on in different ways to evaluate the results.

For Class A, a Geogebra mini-course was held in which the students were presented with the program as a whole and specifically the resources that would be used in the activities.

After this introduction of the *software*, activities involving the construction of the trigonometric circle were developed, exploring: its concepts, the location of sine and cosine and the sketch of the graphs of these functions. Subsequently, activities were developed involving the variations of the parameters in the functions, studying the image, period and domain in each case. The activities were developed by the two classes, remembering that they were adapted for Class B, without *Geogebra*.

ANALYSIS OF RESULTS

ANALYSIS OF ACTIVITIES CARRIED OUT WITH GEOGEBRA

Before the beginning of the activities, for class A that developed the activities with *Geogebra*, a mini-course was held with a duration of 2 hours/classes on *Geogebra* showing the windows and the main tools that would be used in the activities in a computer lab at IFNMG – Salinas Campus. It was noted that the first contact aroused the curiosity of the students for the *Software*, since they identified the dynamism that the use of *Geogebra* provides.

ACTIVITY 1 – CONSTRUCTION OF THE TRIGONOMETRIC CYCLE

The first activity carried out by Class A aimed at the construction and identification of the values of the Sine and Cosine Functions in the Trigonometric Cycle built in the *software*. According to the objectives, Bicudo and Borba (2009) emphasize that the software's potential is manifested by the enormous capacity for numerical and graphical calculation, as well as the use of tools to move freely and coordinate representations. In this aspect, the visual representations of *Geogebra* highlight these resources.

One difficulty perceived in the class was the reading of sine and cosine. It took some time for them to understand that the cosine points were located on the x-axis and the sine points on the y-axis. Emphasizing, therefore, the lack of assimilation to the concepts of axis location in the Cartesian Plan. As also addressed by the curricula in Brazil (2006), the elaboration of a graph by means of the simple transcription of data taken in a numerical table does not allow us to advance in the understanding of the behavior of the functions; Thus, the need for a study of the representations must be associated with their behavior.

This activity was performed in one hour/class, by the researched class, and all students were able to achieve the objectives.

ACTIVITY 2 – CONSTRUCTION AND RECOGNITION OF GRAPHS OF SINE AND COSINE FUNCTIONS

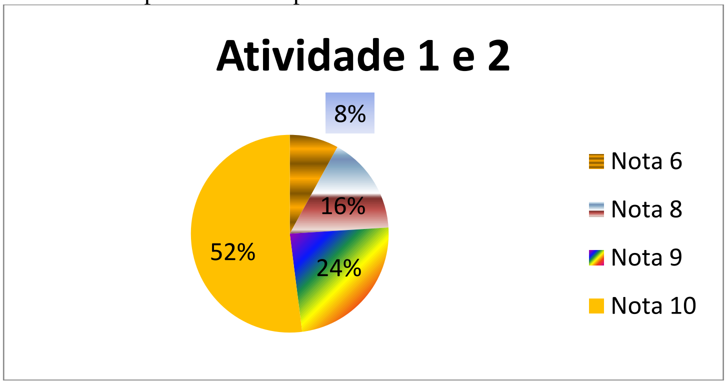
Activity 02 aimed to read the values of the notable arcs from 0 to 360° for sine and cosine; and to fill in the tables with subsequent construction of the graphs of the functions sine, (3),$f(x) = senx$ and cosine, (4),$f(x) = cosx$ from the tables.

One of the doubts arose when moving the point on the circle, because the values found were not exact and so they judged it wrong since they could not locate the points exactly. Brazil (2006) argues that, at this stage of its formation, the development of the ability to estimate the order of magnitude of calculation results or measurements and the ability to deal with exact or approximate numerical values according to the situation and the available instruments, which in this case was requested to approximate as much as possible the exact value.

Activity 02 was performed in one hour/class, and only one of the students did not complete in the mentioned time. It is important to note that the students were able to achieve the objectives of these activities and that they were very enthusiastic about the use of Geogebra for Mathematics activities.

To quantitatively evaluate the activities, it was scored as follows: assembly of the cycle in Geogebra 2 points, reading and assembly of the tables 1 point for each and the graphs were evaluated in 3 points each, totaling 10 points. The performance of the class is shown in Graph 1.

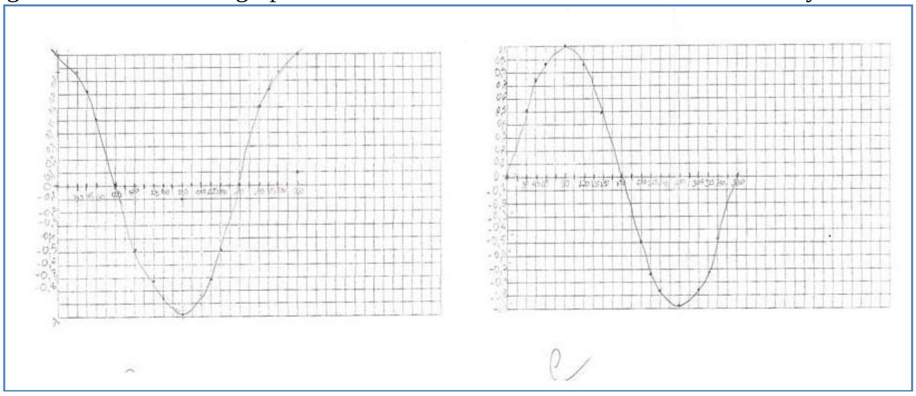
Graph 1: Student performance activities 1 and 2.



Source: Activity 1 and 2 Research

Most of the students achieved the highest grade, as shown in Figure 2. Highlighting the correct chart sketches made by students in the class.

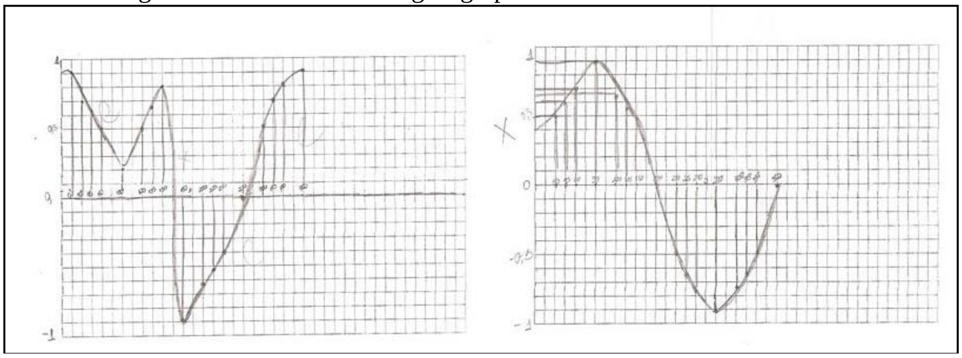
Figure 2: Sketch of the graph of the correct sine and cosine functions made by a student.



Source: Activities 1 and 2 research

Of the students who achieved the lowest score, it was observed that their graphs were incomplete, with incorrect location of the points, and errors in the signs in the table that caused the error of the graphic design. As shown in figure 3.

Figure 3: Incorrect sketching of graphs of sine and cosine functions.



Source: Activities 1 and 2 research

Despite the errors observed, the result of this activity was very good. The students were able to achieve the objectives of the activity, in addition to completing it in the proposed time, being a positive point in the evaluation of the use of the *Software.* The students analyzed *Geogebra* as an adequate alternative to obtain the different representations, which gave them ease, speed and rigor.

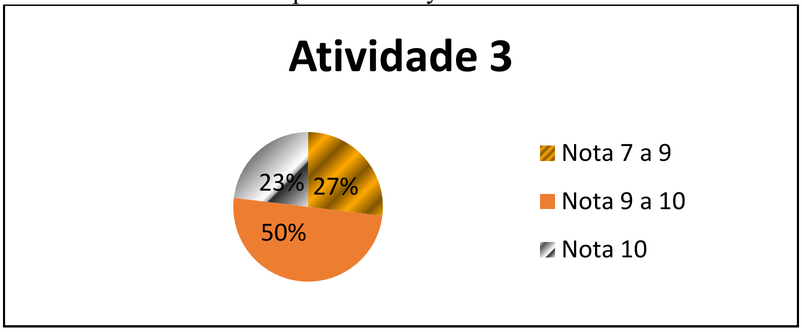
ACTIVITY 3 – IDENTIFICATION OF THE DOMAIN AND IMAGE OF THE FUNCTIONS

The activity had the participation of 26 students, and the objective in this stage was to build several graphs of the Sine and Cosine function; and observe variations in image, period, and function domain through the *Software*. This activity was subdivided into Task I, to construct the graphs of the Sine Function with its variations, and in Task II, to construct the graphs of the Cosine Function with its variations.

The activity was evaluated in 10 points, with 0.5 points for each function, totaling 10 points for the Sine in Task I and 10 points for the Cosine in Task II.

Graph 2 shows the good rate of correct answers obtained in this activity. It is important to highlight the excellent participation of the students, all of them developed the activity showing great interest. In the first answers there were some questions, but then the vast majority did everything right, which is represented in the graph below.

Graph 2: Activity 3 class A.



Source: Activities 3 Survey

To complete this activity, it was necessary 01 hour/class in the researched class. All students achieved the goal of the activity. It was also observed that the students were able to identify the Domain, the Image and the Period of the Functions.

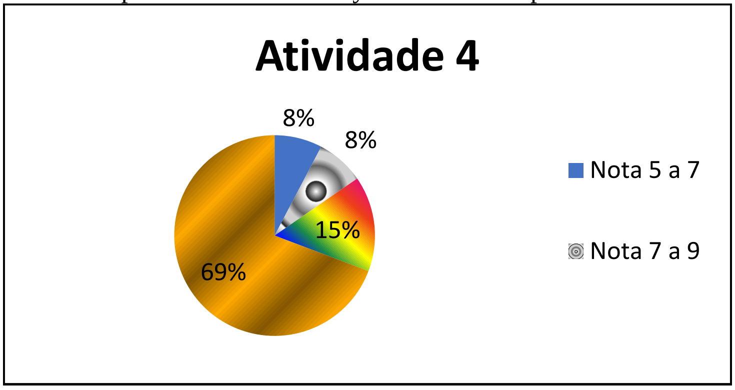
ACTIVITY 4 – VARIATION OF PARAMETERS A, B, C AND D IN THE SINE FUNCTION

The last activity of this class, which was developed with the help of *Geogebra*, aimed to investigate the effects of changes in parameters a, b, c and d on the function (5). After assembling the graph using the variation of the parameters in Geogebra, four open questions were proposed to analyze the behavior of the graph of the given function, through the variation of the elements a, b, c and d. The activity was developed by the 26 students who completed it in one hour/class. $f(x) = [a * \sin(b * x + c)] + d$

It was scored 10 points, with 2.5 points for each question. In these exercises, the goal was for students to describe the behavior of the function graph at each variation of a parameter, observing what changes occurred during the variation, generalizing the behaviors.

In Graph 3, we can see the large number of students who were able to identify the behavior by varying the parameters. As such, these results made it possible to identify how much the students participated positively in the activities. They didn't worry about simply finishing the activity, but about getting the chart variations right. This affirms what is proposed in Brazil (2000), that the study of Trigonometric Functions is linked to applications, avoiding excessive investment in the algebraic calculation of identities and equations to emphasize important aspects such as analysis of the behavior of their graphs.

Graph 3: Result of activity 4: variation of parameters.



Source: Activity 4 Survey

At the end of the activities with *Geogebra,* it was observed that the entire activity had a positive result using the *Software* and the students showed satisfaction with this methodology and reported that they were able to perceive certain situations that in the traditional method they would not notice, especially the variations. In order to compare the use of Geogebra and the traditional methods of teaching Trigonometric Functions, these same activities were adapted and applied in Class B without the aid of *Geogebra,* whose results will be shown below.

ANALYSIS OF ACTIVITIES PERFORMED WITHOUT GEOGEBRA

In Class B, the activities were carried out using only pencils, erasers, rulers and paper. The following is an analysis of the activities applied in this class.

ACTIVITIES 1 AND 2 – CONSTRUCTIONS OF THE GRAPH AND TRIGONOMETRIC CYCLE OF SINE AND COSINE

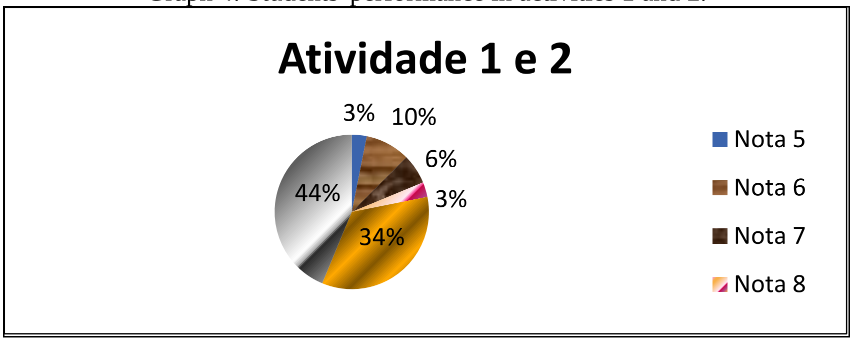
Activities 1 and 2 aimed at the construction of the Trigonometric Cycles with the values of the Sine and the Cosine, with subsequent filling of the tables through the values observed in the Cycles and representations of the functions in the Cartesian plane. To evaluate the activities, it was scored as follows: assembly of the cycle 2 points, reading and assembly of the tables 1 point for each and the graphs were evaluated at 2 points each, totaling 10 points.

It was noticed during the activities that the students in this class could not locate the points, so they were stuck with the need to use formulas and tables to locate the sine. They also exposed difficulties in identifying the signs of the positive and negative functions. Regarding the difficulties presented, Neto (2010) states that the student, when starting his study about the trigonometric circle, is faced with several novelties around the angle: the radian, the irrational π, the definition of radians and their transformations, which constitute obstacles to be faced by educators and students.

In the sketch of the graphs, it was observed that most of the students did not perceive the issue of the ranges of values in the x and y axes, which caused errors in the sketch of the graphs of the functions.

The analysis is presented in Chart 4. Many students were able to get all the questions right, which was expected for this activity. It was observed that there was a higher number of students with lower grades and who did not complete the activities. The need for the construction of graphs is highlighted in the national curricula, where in Brazil (2006) it concerns that students should have the opportunity to draw graphs referring to trigonometric functions, when writing , usually the variable x corresponds to the measure of arc of the circle taken in radians.$f(x) = senx$

Graph 4: Students' performance in activities 1 and 2.



Source: Activities 1 and 2 research

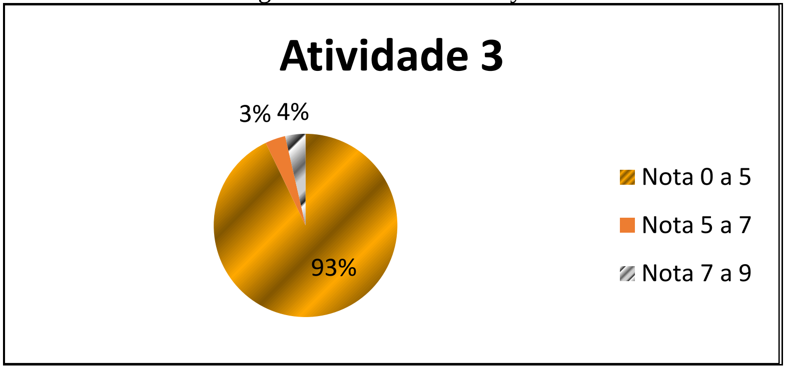
Another issue that drew attention in carrying out the activity was the time spent in the execution, about two hours/class. It is worth mentioning that many students complained about how difficult the activities were and showed less interest than the other class.

ACTIVITY 3 – IDENTIFICATION OF THE DOMAIN, IMAGE AND PERIOD OF THE FUNCTIONS

The activity had the participation of 28 students and aimed to build the graphs of the sine and cosine functions and observe the variations of the image, the period and the domain of the function through the drawings. As in activity 03 with *Geogebra*, it was subdivided into Task I for the Sine function and Task II for the Cosine function. This was evaluated in 10 points, which were evenly distributed for each function, which totaled 5 for the Sine in Task I and 5 for the Cosine in Task II.

Graph 5 shows the score achieved by the students in the activity. As can be seen, the students did not obtain the same results as the classes with *Geogebra*. No one reached the total number of correct answers and almost all students did not get even half of the activity right. The students complained about the excessive use of formulas and tables to be able to draw the graphs and analyze the questions asked.

Figure 5: Result of activity 3.

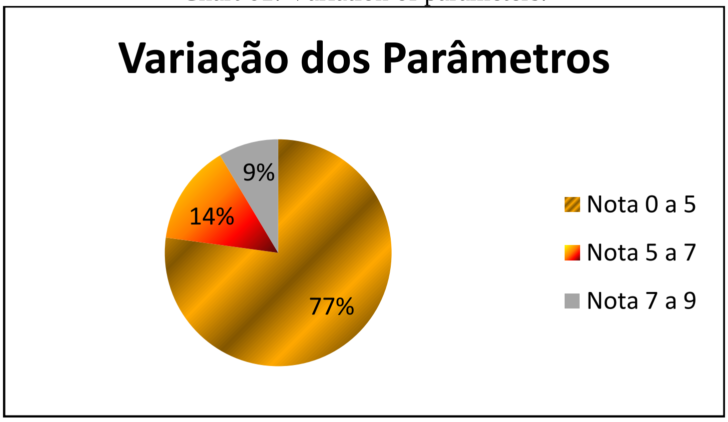


Source: Activity 3 Research

ACTIVITY 3 – VARIATION OF PARAMETERS A, B, C AND D IN SINE AND COSINE FUNCTIONS

Also in activity 3, at the end of each variation with the completion of the tables and graphs drawn, the following was questioned: what he observes of variation in the function, according to Appendix C. These questions aimed to observe the variation of Parameters a, b and c of the Trigonometric Functions, Sine and Cosine. It was evaluated in the same way as the other class, 2.5 points per question. Graph 6 shows the performance achieved by these students, which was considerably lower than that obtained with the use of the *Software*. None of the students were able to get these questions right. The fact that they are unable to visualize such variations is described by Nacarato and Santos (2004), who point out that it is impossible to teach trigonometry without visual aids. But these can't just be static, as with drawing.

Chart 61: Variation of parameters.



Source: Activity 3 Research

By analyzing the execution of the activities in the two classes, using *Geogebra or not*, it was possible to verify that the use of the *software* facilitated the execution, visualization and reduced the time of application of the same activities, since all students were able to complete the activities and obtained a good rate of correct answers, already in the class without the *software*. No one was able to get the whole activity 03 right. As noted, the sequences without *Geogebra* required more use of formulas and tables, as well as more time for the application of the activities. Another important fact to be highlighted is that, unlike Class A, 13 of the 33 students who performed this activity did not complete their work, and complained that it was very difficult and tiring.

FINAL THOUGHTS

Piva, Dorneles and Spilimbergo (2010) highlighted three positive points in their research: the ease of operation of the *software*, and the students' interest and participation in computational activities. They also pointed out that the use of *software* allows simulations, which leads students to build their own analyses and conclusions and, for these reasons, they defend the use of computerized environments in the teaching and learning process of Mathematics.

The need for the use of differentiated methodologies is an important instrument to be studied by us Mathematics teachers and educational institutions. It is pertinent for schools to reflect on this need to adopt diversified methods that arouse the attention and interest of students, such as *educational software*. From this perspective, *Geogebra* was evaluated as an instrument to assist the teaching-learning of Trigonometric Functions, Sine and Cosine.

We can highlight that the *software* can help us in the teaching of trigonometry by assisting in graphic visualization, in understanding the variations in functions, in the interest in working with this discipline and also in the participation of the class in classes.

These statements can be proven in the comparison of the activities developed by the classes, one with the help of the *software* and the other without the tool, when developing the same activities, these were simply adapted to the two situations.

Thus, we can affirm that we were able to answer the questions of this research by finding several contributions of *Geogebra* in the teaching of Sine and Cosine Functions – as we have already emphasized: interest, participation and performance – and we show an alternative of how to use the tools in the program that numerically, in this sample studied, was shown to be efficient in learning the content addressed.

The handling of this *software* allows in a simplified way to vary the functions and make various observations and corrections in drawings, graphs and formulas, enabling the resolution of activities more quickly, reducing the time of application of the content, favoring the fulfillment of the curricular matrix of Teaching.

As for the objectives of this research, it was noticed that when developing the activities with and without *Geogebra,* the *software* is a facilitating means in the teaching-learning process and seen as something interesting and motivating by the students, mainly because it promotes a better visualization of the Functions.

Finally, it is important to ratify that the use of new methodologies is not the act of solving the problems that involve the teaching of Mathematics. And yes, something that must be constantly reflected on by the school and teachers, as a way to achieve the main objective: student learning.

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