USING THE CIDEPE CHART AS A TEACHING TOOL FOR LEARNING TRIGONOMETRY

UTILIZANDO O QUADRO CIDEPE COMO FERRAMENTA DIDÁTICA PARA APRENDIZAGEM DE TRIGONOMETRIA

UTILIZACIÓN DE LA TABLA CIDEPE COMO HERRAMIENTA DIDÁCTICA PARA EL APRENDIZAJE DE LA TRIGONOMETRÍA

https://doi.org/10.56238/sevened2026.022-017

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ABSTRACT

The research was motivated by the need to overcome traditional and fragmented teaching of trigonometry, which prioritizes algebraic and static geometric approaches, hindering students' conceptual understanding. The main objective was to promote a more dynamic and intuitive learning process by employing the CIDEPE Board as a didactic tool, combined with historical contextualization and active student participation. The methodology was based on explanatory research and action research, using quantitative and qualitative questionnaires, as well as group activities with the didactic material, which represents the trigonometric cycle with a movable diameter. The results indicated a high level of student satisfaction, particularly regarding positive self-perception of learning and the deepening of essential details, such as determining quadrants. It is concluded that the success of the proposal is due not only to the material resource but also to the historical and interactive teaching approach, corroborating previous research in the field.

Keywords: Trigonometry Teaching. Manipulable Didactic Material. CIDEPE Framework. Active Learning. Critical Mathematics Education.

RESUMO

A motivação da pesquisa reside na necessidade de superar o ensino tradicional e discretizado da trigonometria, que prioriza abordagens algébricas e geométricas estáticas, dificultando a compreensão dos conceitos. O objetivo central foi promover uma aprendizagem mais dinâmica e intuitiva, utilizando o Quadro CIDEPE como ferramenta didática, aliado à contextualização histórica e à participação ativa dos estudantes. A metodologia baseou-se na pesquisa explicativa e na pesquisa-ação, aplicando questionários quanti-qualitativos e organizando atividades em grupo com o material didático, que representa o ciclo trigonométrico com um diâmetro móvel. Os resultados indicaram elevado grau de satisfação entre os aprendizes, com

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destaque para a percepção positiva sobre a própria aprendizagem e o aprofundamento de detalhes essenciais, como a determinação de quadrantes. Conclui-se que o sucesso da proposta não se deve apenas ao recurso material, mas também à condução do processo histórico e interativo, corroborando pesquisas da área.

Palavras-chave: Ensino de Trigonometria. Material Didático Manipulável. Quadro CIDEPE. Aprendizagem Ativa. Educação Matemática Critica.

RESUMEN

La motivación de esta investigación radica en la necesidad de superar la enseñanza tradicional y fragmentada de la trigonometría, que prioriza los enfoques algebraicos y geométricos estáticos, dificultando la comprensión de los conceptos. El objetivo central fue promover una experiencia de aprendizaje más dinámica e intuitiva, utilizando el Marco CIDEPE como herramienta didáctica, combinada con la contextualización histórica y la participación activa del alumnado. La metodología se basó en la investigación explicativa y la investigación-acción, aplicando cuestionarios cuantitativos y cualitativos y organizando actividades grupales con el material didáctico, que representa el círculo trigonométrico con diámetro móvil. Los resultados indicaron un alto grado de satisfacción entre el alumnado, destacando la percepción positiva de su propio aprendizaje y la profundización de detalles esenciales, como la determinación de los cuadrantes. Se concluye que el éxito de la propuesta se debe no solo al recurso material, sino también a la conducción del proceso histórico e interactivo, que corrobora la investigación en el área.

Palabras clave: Enseñanza de la Trigonometría. Material Didáctico Manipulable. Marco CIDEPE. Aprendizaje Activo. Educación Matemática Crítica.

1 INTRODUCTION

In order for the learning of mathematics to transcend mere technique, it is essential that the educational process facilitates the understanding of concepts in their entirety, considering their need for scientific development, their applications in everyday life and their historical role in the evolution of humanity. From the perspective of **Critical Mathematics Education (CME),** teaching should not be neutral; it should promote autonomy and dialogue, allowing the student to understand how mathematics can format reality (SKOVSMOSE, 2001). However, trigonometry content is often developed in a discretized and static way, prioritizing purely geometric or algebraic approaches that make it difficult to perceive its dynamic nature.

In this context, Belonsi et al. (2017) proposed a paradigm shift, focusing on trigonometric concepts in a more intuitive way through didactic tools, respecting the individual learning time of each subject. In contrast to most textbooks that excessively emphasize algebraic formalism, an approach centered on **the manipulable didactic material CIDEPE** is sought here. This proposal is in line with the vision of Silva (2013), who defends teaching through practical activities, games and software, ensuring that the deepening of the content occurs in a meaningful and age-appropriate way.

The incorporation of these resources aims to transform the classroom into an **investigation scenario**, where students cease to be passive receptors to become protagonists in the construction of knowledge. For CME, this change in posture is crucial for the development of a critical citizenship (SKOVSMOSE, 2008). Thus, the use of historical context, as suggested by Ferreira, Araújo and Sakon (2016), acts as a powerful tool to humanize the discipline, facilitating the transition between the properties of the right triangle and the trigonometric cycle.

Although Mendes (1997) emphasizes that the use of history does not solve all the obstacles to learning, he recognizes its potential to minimize them, evidencing the social value of mathematics. Baroni, Teixeira and Nobre (2004) corroborate this view, stating that such a methodology meets various educational needs and strengthens the presence of mathematics in the classroom. In addition, Xavier, Tenório and Tenório (2015) highlight that methods enriched by technological resources and manipulable surpass traditional teaching, demonstrating that the effectiveness of learning should be measured by qualitative and not just quantitative criteria.

Thus, the present work is based on the motivation of learners through history and direct experimentation with the CIDEPE framework. The objective is that, by appropriating this material, students develop not only technical skills, but also the ability to critically reflect on the knowledge they are building.

2 METHODOLOGY

The methodology of this work is based on an interpretative and dialogical perspective (GIL, 2008), understanding that the teaching-learning process is a collective construction where "content-method-teaching-learning have corroborative actions" and require the active involvement of all subjects. In line with the precepts of **Critical Mathematics Education (CME),** the research assumes the character of **Action Research**, as proposed by Thiolent (1996), aiming not only to describe reality, but to produce knowledge that promotes the transformation of educational practices and the social reality of the classroom.

To transcend the traditional model of information transmission, the approach was structured to create an **investigation scenario**. Unlike paradigm exercises (focused only on correct answers), this scenario seeks the development of reflective skills through the exploration of trigonometric concepts. The research is also classified as explanatory, as it seeks to identify the factors that arouse the interest and autonomy of learners in dealing with mathematics.

The methodological path was divided into four fundamental moments, designed to promote student protagonism:

I. **Contextualization and Demystification:** Initially, a material was delivered that associates trigonometry with historical elements and curiosities, such as the "shadow function", seeking to humanize knowledge and demonstrate its evolution as a response to human needs.

II. **Historical-Visual Dialogue:** Through visual resources and dialogued explanation, the genesis of trigonometry and the role of the subjects who developed it were discussed, avoiding the presentation of mathematics as a ready-made and unquestionable knowledge.

III. **Presentation of the Research Object: The** CIDEPE trigonometric table **was introduced**, a manipulable material that represents the trigonometric cycle with a movable diameter. At this time, the material was presented not only as a calculation tool, but as a support for the investigation of metric relationships and functions.

IV. **Collective Investigation in Groups:** The students were organized into groups to handle the CIDEPE board. This stage aimed to stimulate cooperation and dialogue between peers, allowing students to build tables of values and scatter plots autonomously.

Data collection occurred through a quantitative-qualitative questionnaire that sought to capture both the appropriation of technical concepts and the degree of satisfaction and perception of students about their own learning. According to EMC, the evaluation was not

limited to the technical accuracy, but valued critical interventions, such as the doubts that arose about the determination of quadrants in remarkable arcs, which shows an investigative posture and attentive to the essential details of knowledge.

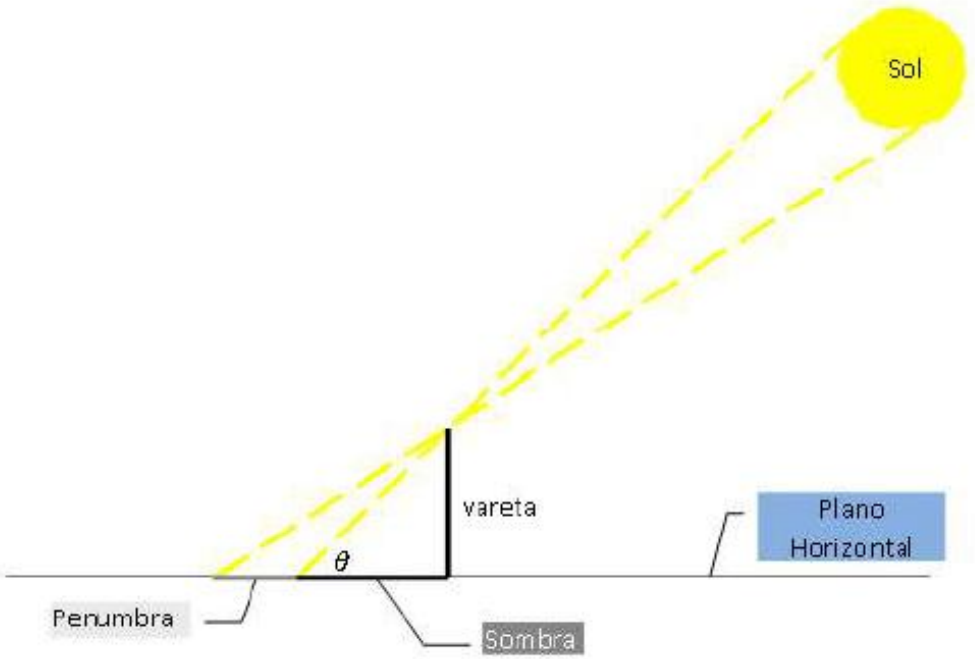
Thus, the proposed methodology sought to treat the study of trigonometric functions in such a way that the learner could be the protagonist of his process, respecting his particularities and learning times.

3 DEVELOPMENTS AND RESULTS

In addition to a historical survey presented in a dialogued way to the participants, the manipulable part of the activity was developed in four moments. The first occurred with the delivery of the material containing an introduction with history and curiosities about trigonometry, as an example: the curiosity of the tangent function or shadow function when it was associated with the shadows projected by a vertical rod, Fig. 1. and, some activities on the content to be solved at the end of the activity with the use of the CIDEPE trigonometric table. In a second moment, the history of trigonometry was exposed in more detail through an explanation using the visual resource.

Figure 1

Illustration of a shadow and penumbra formation from the sun's rays



Source: Authors.

Thus, during the explanation, a historical survey of the origins of trigonometry was

addressed, as well as the first subjects who entered the field of study and development of trigonometry.

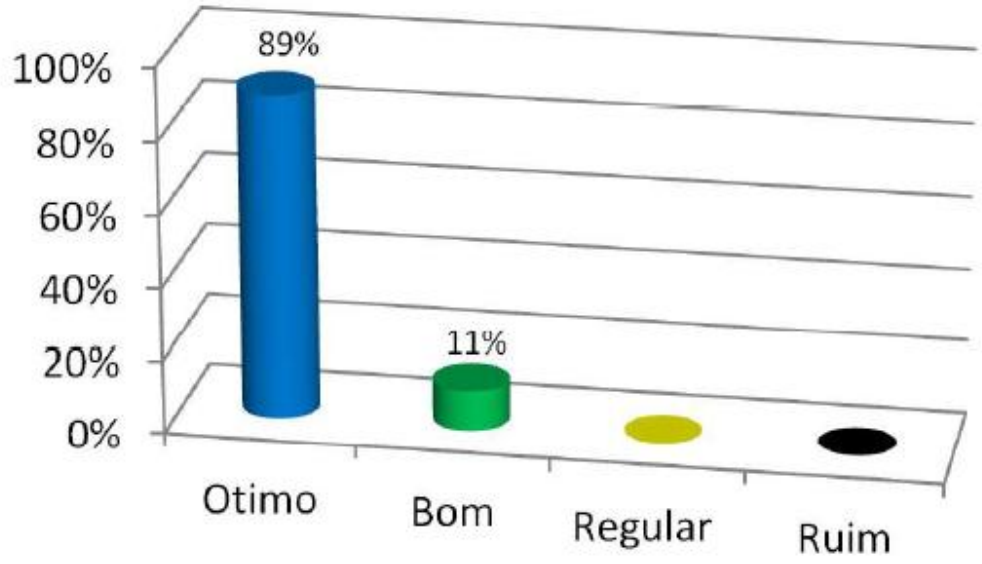
Thirdly, the CIDEPE trigonometric table was presented, as well as its use and its functional potential in the learning of trigonometry contents. Finally, in the fourth moment, the students were divided into groups, each receiving a CIDEPE board, aiming at the development of skills and competencies necessary to obtain the desired objectives.

The CIDEPE trigonometric table is a didactic material that has a representation of a trigonometric cycle to which a movable diameter is attached. More details about the material can be found on the website of the company Cidepe. (CIDEPE, 2018).

Among its functions, we can list those related to the study of measurements; metric relations in the right triangle, Pythagorean theorem, trigonometric relations in the right triangle (sine, cosine, and tangent), trigonometric relations in the circumference (sine, cosine, and tangent), etc. With the application of the proposal, it was possible to collect, from an activity questionnaire, information about the perception of the learners regarding the methodology used. Fig. 2 shows the results of perception and satisfaction on the part of the learners regarding the activity developed.

Figure 2

Results of the self-assessment regarding learning



Source: Authors.

From Fig. 2 it is possible to perceive a degree of satisfaction on the part of the learners with respect to the proposed activity, a very satisfactory degree of acceptance of the proposal is observed, considering that there was no attribution of regular or very bad answers on the part of the participants. The non-conceptualization of the activity as regular, combined with the low

percentage of good concepts, leads to the inference that such activity produced the expected qualitative objectives.

It is worth highlighting the intervention of one of the learners regarding his observation in the treatment of the study of the quadrants in the trigonometric cycle. At this moment, this subject questioned about the determination of the quadrant of the arcs of 0°, 90°, 180°, 270°, 360°, which evidences the potential of the tool to divert the subjects' attention to the details that are generally essential elements for the quality of learning, as learning presupposes the development of competencies about a certain content as a whole.

It is also worth noting that, according to the analysis of the results obtained from the evaluation questionnaire, it was possible to identify an ease of understanding regarding the identification of the shape of the graph of the sine, cosine and tangent functions, since the evaluation form contained elements to determine the values of these functions in the different angular values: 00, 300, 450, 600, 1200, 1500, 1800, 2100, 2250, 2400, 2700, 3000, 3150, 3300 and finally 3600. Enabling the construction of the table of values and, consequently, the construction of a scatter diagram, on graph paper.

At the end of this construction, the apprentices concluded, each one in their own time and, respecting their learning particularities, the form of the graphic representation of sine and cosine. Hence, it was perceived that such elements could be treated as functions, since a correspondence between two sets could be associated with them, one being the set of arcs or angles (domain) and the other the set of real numbers (counterrange), so that such association enjoyed the fundamental properties of function. Evidencing a way of treating the study of trigonometric functions that corroborate with the facilitation of learning through a manipulation material capable of inserting the learner as the protagonist of his learning.

4 FINAL CONSIDERATIONS

First, it is worth mentioning that the apprentices, during and after the work carried out, reported comments about the activity and the didactic material used. According to them, the CIDEPE trigonometric table allowed greater interactivity between the content and the students, thus making its understanding more accessible. Such was the interest in this form of approach that the existence of the painting on a smaller and lighter scale was inquired, in order to facilitate its use in an individualized way.

The analysis of the results allows us to affirm that the central objectives of this research were fully achieved, managing to overcome the traditional and static teaching of trigonometry in favor of a dynamic and intuitive learning. The transformation of the classroom into an

investigation scenario allowed students to leave the posture of passive receptors to become protagonists in the construction of knowledge, respecting their rhythms and individual particularities.

The **Action Research methodology** proved to be effective in integrating the use of the **CIDEPE trigonometric table** with historical contextualization, promoting a dialogical environment where the content was not presented as an absolute truth, but as a human construction. The high degree of satisfaction of the learners and the absence of negative evaluations corroborate that the practical and manipulable approach enhances the interest and natural assimilation of the concepts.

From EMC's point of view, it is imperative to highlight that the success of the proposal did not reside only in the material resource, but in the ability to arouse critical reflection. Evidence of this was the autonomy of the subjects when questioning essential details, such as the determination of quadrants in remarkable arcs, which demonstrates the development of competencies that go beyond mere technical execution. The transition from physical experimentation with the moving diameter to the construction of tables and scatter plots on graph paper facilitated the understanding of trigonometric functions as dynamic and real relations.

In short, this work reaffirms that the use of manipulable materials, when mediated by a historical and interactive conduction, strengthens the presence of mathematics in the classroom and meets the various educational needs. It is concluded that the methodology applied not only facilitated technical learning, but also fostered autonomy and critical citizenship, fundamental pillars for the student to understand mathematics as a tool capable of formatting and interpreting reality.

ACKNOWLEDGMENTS

The authors thank the State University of Goiás for encouraging and providing human and structural resources for the development of this research work.

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