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A SYSTEM OF DIDACTIC ACTIONS FOR LEARNING TRIGONOMETRIC RATIOS AMONG 11TH-GRADE STUDENTS AT SUMBE HIGH SCHOOL, CUANZA-SUL, ANGOLA

SISTEMA DE ACÇÕES DIDÁCTICAS PARA A APRENDIZAGEM DAS RAZÕES TRIGONOMÉTRICAS NOS ALUNOS DA 11.ª CLASSE DO LICEU DO SUMBE, CUANZA-SUL, ANGOLA

SISTEMA DE ACCIONES DIDÁCTICAS PARA EL APRENDIZAJE DE LAS RAZONES TRIGONOMÉTRICAS EN LOS ALUMNOS DE 11.º GRADO DEL LICEO DE SUMBE, CUANZA SUR, ANGOLA

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Abstract: This article discusses the implementation of a system of didactic actions for learning trigonometric ratios among 11th-grade students at Liceu do Sumbe, Cuanza-Sul Province, Angola. The study emerged from the need to address students' difficulties in understanding and applying the concepts of sine, cosine and tangent. The research is based on the principles of meaningful learning and active methodologies, emphasizing student participation in the construction of mathematical knowledge. Methodologically, the study relied on bibliographic and documentary research, supported by theoretical and empirical methods. The expected results indicate improvements in academic performance, motivation and problem-solving skills. It is concluded that the implementation of a structured system of didactic actions can

significantly contribute to the quality of mathematics teaching and to the development of competencies required by the Angolan secondary education curriculum.

Keywords: didactic actions; trigonometric ratios; meaningful learning; mathematics teaching; 11th grade.

Resumo: O presente artigo aborda a implementação de um sistema de acções didácticas para a aprendizagem das razões trigonométricas nos alunos da 11.ª Classe do Liceu do Sumbe, província do Cuanza-Sul, Angola. A investigação surge da necessidade de responder às dificuldades evidenciadas pelos alunos na compreensão e aplicação dos conceitos de seno, cosseno e tangente. O estudo fundamenta-se nos princípios da aprendizagem significativa e das metodologias activas, valorizando a participação dos alunos na construção do conhecimento matemático. Metodologicamente, recorreu-se à pesquisa bibliográfica e documental, complementada por métodos teóricos e empíricos. Os resultados esperados apontam para uma melhoria do desempenho académico, da motivação e da capacidade de resolução de problemas matemáticos. Conclui-se que a implementação de um sistema estruturado de acções didácticas pode contribuir significativamente para a qualidade do ensino da Matemática e para o desenvolvimento das competências previstas no currículo do Ensino Secundário angolano.

Palavras-chave: acções didácticas; razões trigonométricas; aprendizagem significativa; ensino da Matemática; 11.ª Classe.

Resumen: El presente artículo aborda la implementación de un sistema de acciones didácticas para el aprendizaje de las razones trigonométricas en los alumnos del 11.º grado del Liceo del Sumbe, provincia de Cuanza-Sul, Angola. La investigación surge de la necesidad de responder a las dificultades evidenciadas por los alumnos en la comprensión y aplicación de los conceptos de seno, coseno y tangente. El estudio se fundamenta en los principios del aprendizaje significativo y de las metodologías activas, valorando la participación de los alumnos en la construcción del conocimiento matemático. Metodológicamente, se recurrió a la investigación bibliográfica y documental, complementada con métodos teóricos y empíricos. Los resultados esperados apuntan a una mejora del rendimiento académico, de la motivación y de la capacidad de resolución de problemas matemáticos. Se concluye que la implementación de un sistema estructurado de acciones didácticas puede contribuir significativamente a la calidad de la enseñanza de la Matemática y al desarrollo de las competencias previstas en el currículo de la Educación Secundaria angoleña.

Palabras clave: acciones didácticas; razones trigonométricas; aprendizaje significativo; enseñanza de la Matemática; 11.º grado.

1. Introduction

Mathematics is one of the fundamental disciplines for the scientific, technological and social development of contemporary societies. Its importance lies in its capacity to develop logical reasoning, critical thinking and problem-solving skills, which are essential elements in students' comprehensive education. Within Angolan secondary education, Mathematics plays a relevant role in preparing students for academic and professional challenges, contributing to

their understanding of everyday phenomena and to the continuation of studies in scientific and technological fields.

Among the subjects in the 11th-grade syllabus, trigonometric ratios—namely sine, cosine and tangent—stand out. These topics are particularly important because they provide the basis for understanding several geometric and physical phenomena and have applications in fields such as Engineering, Architecture, Surveying, Navigation and Telecommunications.

Despite their relevance, learning trigonometric ratios remains a challenge for many students. Difficulties are frequently observed in understanding the fundamental concepts, identifying the relationships among the elements of a right triangle and applying the knowledge acquired in practice. These difficulties may compromise students' academic performance and limit the acquisition of essential mathematical skills.

According to Moreira (2021), learning becomes more meaningful when new knowledge is related to knowledge already present in the student's cognitive structure. From this perspective, it is essential for teachers to adopt didactic strategies that encourage students' active participation and promote the meaningful construction of mathematical knowledge.

Given the relevance of trigonometric ratios to students' mathematical education and considering the difficulties frequently observed in learning them, it is necessary to analyse the specific context in which this problem occurs. Understanding the educational reality of Sumbe High School will make it possible to identify the factors that influence the teaching-learning process and substantiate the need to implement a system of didactic actions aimed at improving students' academic performance.

2. Contextualization of the Problem

The Angolan education system has been implementing curricular reforms aimed at improving the quality of teaching and learning. These reforms seek to respond to the demands of a society that is increasingly dependent on scientific and technological knowledge. However, despite the progress achieved, challenges persist in Mathematics teaching, particularly regarding content that requires high levels of abstraction and reasoning ability.

At Sumbe High School, located in Cuanza-Sul Province, Mathematics teachers have observed recurring difficulties among 11th-grade students in learning trigonometric ratios. These difficulties appear in identifying the legs and hypotenuse, interpreting the concepts of sine, cosine and tangent, and solving problems that require the application of these ratios.

In addition to cognitive aspects, students also show limited motivation to learn Trigonometry. Many students consider this subject excessively abstract and removed from everyday situations, which limits their participation in classroom activities.

The scarcity of didactic resources, the predominant use of lecture-based methodologies and the limited contextualization of content are factors that may aggravate this situation. Consequently, it is necessary to develop pedagogical strategies that connect mathematical content with students' reality and promote more meaningful learning.

An analysis of the educational reality shows that difficulties in learning trigonometric ratios are not an isolated situation but a recurring challenge in the Mathematics teaching-learning process. These limitations justify the need for deeper scientific reflection, leading to the formulation of the problem that guides this study.

3. Problem Statement

The difficulties encountered in learning trigonometric ratios are a continuing concern for teachers and researchers in Mathematics Education. Although these topics are regularly addressed in the 11th-grade curriculum, many students continue to show limitations in understanding the fundamental concepts and solving related exercises.

This reality highlights the need to seek methodological alternatives capable of improving the teaching-learning process and promoting greater student participation in the construction of mathematical knowledge. Finding solutions to this problem requires systematic research to identify didactic strategies suited to the educational context under analysis.

Accordingly, the following scientific problem is formulated:

How can the implementation of a system of didactic actions contribute to improving the learning of trigonometric ratios among 11th-grade students at Sumbe High School?

The formulation of this problem represents not only an academic concern but also a pedagogical challenge that requires concrete and well-founded responses. It is therefore appropriate to present the reasons that justify carrying out this study.

4. Rationale

This study is justified by the importance of trigonometric ratios in students' mathematical education and by the need to improve the learning outcomes observed in the 11th grade at Sumbe High School.

From a scientific perspective, the study contributes to deepening knowledge related to Mathematics teaching and to the use of innovative methodologies applied to learning Trigonometry. It may also enrich scientific production on Mathematics Education in the Angolan context.

From a pedagogical perspective, the study proposes a set of didactic actions that may assist teachers in improving their educational practices by promoting methodologies that are more participatory, contextualized and student-centred.

From a social perspective, the study may contribute to educating students who are better prepared to face the academic and professional challenges of contemporary society. Mastery of mathematical skills is currently a fundamental requirement for individual and collective development.

Considering the relevance of the topic and the need to find solutions to the difficulties identified, it is essential to define the objectives that will guide the development of the study.

5. Research Objectives

5.1 General Objective

To propose a system of didactic actions that contributes to improving the learning of trigonometric ratios among 11th-grade students at Sumbe High School, Cuanza-Sul Province, Angola.

5.2 Specific Objectives

To diagnose the main difficulties students experience when learning trigonometric ratios.

To provide a theoretical foundation for the teaching-learning process of trigonometric ratios.

To develop a system of didactic actions suited to the educational context of Sumbe High School.

To promote meaningful learning of the concepts of sine, cosine and tangent.

To contribute to improving students' academic performance in Mathematics.

The objectives presented define the results to be achieved throughout the study. Accordingly, the object of study is presented below.

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Object of Study

The object of this study is the Mathematics teaching-learning process in secondary education, with particular emphasis on 11th-grade students' learning of trigonometric ratios. This delimitation arises from the importance of Mathematics in developing students' logical, critical and abstract thinking, as well as from the role of Trigonometry in consolidating knowledge that is essential for continuing scientific and technological studies.

The choice of this object of study is based on the need to understand the factors that interfere with the process of learning Trigonometry, especially the appropriation of the concepts of sine, cosine and tangent, the interpretation of their geometric representations and the application of this knowledge in solving mathematical problems. In this regard, it is essential to identify didactic strategies that foster more meaningful, active and contextualized learning, thereby contributing to improving the quality of Mathematics teaching at this level of education.

Thus, the study seeks to analyse the relationships among the teaching methods used, the difficulties experienced by students and the possibilities for pedagogical intervention through an organized system of didactic actions.

Field of Action

Considering the object of study defined, the field of action of this study focuses on a system of didactic actions for learning trigonometric ratios (sine, cosine and tangent) among 11th-grade students at Sumbe High School, Cuanza-Sul Province, Angola.

Delimiting this field makes it possible to direct the study toward the organization, structuring and application of pedagogical strategies that can foster students' understanding of trigonometric content. The study is therefore not limited to analysing existing difficulties; it also seeks to propose methodological alternatives that contribute to transforming the teaching-learning process.

In this context, the field of action highlights the study's scientific intervention, aimed at improving the practices of Mathematics teachers through the implementation of didactic activities grounded in the principles of Mathematics Education, active methodologies, problem solving and the use of appropriate educational resources.

Scientific Tasks

To achieve the general and specific objectives established, scientific tasks were defined to guide the systematic development of the study. These tasks organize its different stages, from the theoretical foundation to the development and analysis of the didactic proposal.

Accordingly, the following scientific tasks were established:

To review the scientific literature related to Mathematics Didactics, meaningful learning, active methodologies and the theoretical foundations of teaching trigonometric ratios, in order to build the study's conceptual basis.

To characterize the teaching-learning process of trigonometric ratios in the 11th grade at Sumbe High School by analysing the pedagogical practices developed, the methods used by teachers and the existing conditions for student learning.

To diagnose the main difficulties students experience in understanding and applying the concepts of sine, cosine and tangent, identifying limitations related to prior knowledge, geometric interpretation and problem solving.

To identify the pedagogical, methodological and contextual factors that influence students' performance in learning Trigonometry, considering the relationship among teacher, student, content and didactic resources.

To design a system of didactic actions grounded in the scientific premises of Mathematics Education, with a view to providing better conditions for the construction of trigonometric knowledge.

To structure teaching-learning activities that integrate active methodologies, problem solving, cooperative learning, technological resources and contextualized situations in order to encourage students' active participation.

To analyse the contribution of the didactic proposal to improving the learning of trigonometric ratios and pedagogical practices at Sumbe High School, assessing its potential as a methodological alternative for Mathematics teaching.

CHAPTER I – THEORETICAL FOUNDATION

1.1 Didactics and Mathematics Teaching

Didactics is one of the fundamental fields of Educational Sciences and is devoted to studying teaching and learning processes, teaching methodologies, didactic resources and forms

of assessment. Its main objective is to understand and improve the conditions that foster student learning, promoting comprehensive and meaningful education.

According to Libâneo (2023), Didactics is the pedagogical discipline that studies the objectives, content, methods and forms of teaching organization, seeking to establish relationships between educational theory and practice. From this perspective, teaching should not be limited to transmitting knowledge but should create conditions for students to participate actively in constructing knowledge.

In the context of Mathematics, Didactics assumes even greater importance because of the abstract nature of much of the content addressed. Understanding mathematical concepts requires pedagogical strategies that allow students to relate theoretical knowledge to concrete everyday situations. The teacher should therefore act as a learning mediator, organizing activities that stimulate observation, analysis, reflection and problem solving.

The development of educational theories has led to the appreciation of student-centred methodologies, progressively replacing traditional models based exclusively on verbal exposition of content. From this new perspective, the student ceases to be a mere recipient of information and assumes an active role in the learning process.

According to Perrenoud (2021), teaching consists of creating situations that enable students to construct knowledge, develop skills and mobilize what they know to solve real problems. This conception reinforces the need to adopt innovative pedagogical practices that promote meaningful and lasting learning.

Thus, Didactics provides the foundations needed to understand the importance of the pedagogical strategies used in Mathematics teaching. However, for the teaching-learning process to achieve the desired results, it is necessary to understand more specifically the role of didactic actions in organizing educational activities.

1.2 Didactic Actions in the Teaching-Learning Process

Didactic actions correspond to the set of activities planned and carried out by the teacher for the purpose of promoting student learning. These actions include defining teaching objectives, selecting content, choosing didactic methods and resources, and organizing assessment activities.

According to Zabala (2020), didactic actions should be designed in an articulated manner, allowing students to build knowledge progressively through interaction with content,

classmates and the teacher. This perspective demonstrates the importance of carefully planning educational activities.

In Mathematics teaching, didactic actions are particularly relevant because they make it possible to transform abstract concepts into concrete learning situations. The use of manipulatives, visual resources, digital technologies and investigative activities fosters understanding of the content and helps reduce the difficulties frequently experienced by students.

One of the main characteristics of didactic actions is their capacity to promote students' active participation. When students are involved in solving problems, carrying out experiments and discussing ideas, they become more motivated and develop a deeper understanding of the content studied.

Didactic actions also make it possible to adapt the teaching process to students' specific characteristics. This flexibility is particularly important in heterogeneous educational contexts in which different learning rates and styles coexist.

In learning trigonometric ratios, didactic actions may include activities for measuring heights, observing objects in the surrounding environment, using educational software and solving contextualized problems. These strategies help make the content more meaningful and closer to students' reality.

The effectiveness of didactic actions is directly related to the way students attribute meaning to the knowledge acquired. For this reason, it is appropriate to analyse the principles of meaningful learning and their relationship with Mathematics teaching.

1.3 Meaningful Learning

The theory of meaningful learning was developed by David Ausubel and is one of the main theoretical references for understanding school learning processes. According to this theory, learning occurs meaningfully when new knowledge is related to knowledge already present in the student's cognitive structure.

According to Moreira (2021), meaningful learning occurs when students establish non-arbitrary relationships between new content and previously acquired knowledge. This connection enables a deeper understanding of concepts and favours long-term knowledge retention.

Unlike rote learning, which is based on simply memorizing information, meaningful learning promotes understanding of content and the ability to apply it in different contexts. In

this sense, students cease to memorize meaningless formulas and begin to understand the logic underlying mathematical concepts.

When trigonometric ratios are taught, meaningful learning requires students to possess prior knowledge related to Geometry, right triangles and the properties of angles. Teachers should explore this knowledge before introducing new content, creating conditions for students to establish relationships between information they already know and the concepts they are learning.

Contextualizing content is also a fundamental element of meaningful learning. When students can perceive the practical usefulness of mathematical knowledge, they tend to show greater interest and engagement in the proposed activities.

Therefore, meaningful learning provides important foundations for organizing the teaching of trigonometric ratios. However, to understand this process more fully, it is necessary to analyse specifically how this content is addressed in the 11th-grade curriculum.

1.4 Teaching Trigonometric Ratios in the 11th Grade

Trigonometric ratios are one of the fundamental topics in the 11th-grade Mathematics programme of Angolan secondary education. Their study aims to develop skills related to interpreting geometric relationships, solving problems and applying mathematical knowledge in practice.

In the Angolan curriculum, trigonometric ratios are introduced through the study of the right triangle. Students learn to identify the legs and hypotenuse and to establish relationships between sides and angles through the sine, cosine and tangent functions.

Understanding these concepts makes it possible to solve a wide variety of problems involving heights, distances and inclinations. It also provides an indispensable basis for studying more advanced Mathematics content and related disciplines.

Despite their importance, several studies indicate that many students experience difficulties in learning Trigonometry. These difficulties are frequently associated with the abstract nature of the concepts, the inappropriate use of teaching methodologies and the limited contextualization of content.

Overcoming these difficulties requires the adoption of pedagogical strategies that value students' active participation and promote the application of knowledge in concrete situations. In this context, it is relevant to analyse the main obstacles that affect the learning of trigonometric ratios.

1.5 Difficulties in Learning Trigonometric Ratios

Difficulties in learning trigonometric ratios have been widely discussed in the specialized literature. Several authors recognize Trigonometry as one of the areas of Mathematics in which students have the highest failure rates.

The most frequent difficulties include incorrectly identifying the elements of a right triangle, confusing the different trigonometric ratios and improperly applying mathematical formulas. These limitations make problem solving difficult and compromise the learning of subsequent content.

Another relevant aspect is the excessive emphasis on memorization at the expense of conceptual understanding. Many students can reproduce formulas but do not understand their meaning or know when to use them appropriately.

The lack of contextualization of content is also a factor that contributes to learning difficulties. When students cannot relate mathematical concepts to everyday situations, they tend to consider the content abstract and of little relevance.

In addition, insufficient didactic resources and the predominance of traditional methodologies may limit opportunities to explore and discover mathematical concepts.

Identifying these difficulties makes it possible to understand the need to adopt strategies that bring the content closer to students' reality. Accordingly, it is important to analyse the relevance of trigonometric ratios to everyday life and to different areas of knowledge.

1.6 Importance of Trigonometric Ratios in Everyday Life

Trigonometric ratios have numerous practical applications in different sectors of human activity. Although students often perceive them as exclusively school-based content, they are used in various professions and everyday activities.

In Civil Engineering, for example, trigonometric ratios are used to calculate heights, slopes, distances and structural dimensions. Similarly, in Architecture they make it possible to determine the measurements needed to prepare construction projects.

In Surveying, Trigonometry is used to measure land, calculate areas and prepare maps. Professionals in this field frequently use trigonometric ratios to determine inaccessible distances without the need for direct measurements.

Applications also extend to maritime and air navigation, telecommunications, Astronomy and Physics, demonstrating the importance of this knowledge to scientific and technological development.

In the educational context, presenting these applications helps increase students' motivation and foster understanding of the content. When students perceive the practical usefulness of Trigonometry, they become more involved in the learning process and better able to attribute meaning to the knowledge acquired.

In summary, the theoretical foundation presented shows that learning trigonometric ratios depends on the adoption of appropriate pedagogical strategies grounded in the principles of Didactics, didactic actions and meaningful learning. These premises support the methodological proposal of this study, which is described in the following chapter.

CHAPTER II – RESEARCH METHODOLOGY

2.1 Methodological Introduction

Methodology is a fundamental element of any scientific study because it guides the procedures needed to obtain, analyse and interpret data. According to Gil (2021), methodology represents the set of methods, techniques and procedures used by the researcher to achieve the defined objectives and answer the scientific problem formulated.

In this study, the methodology was designed to ensure coherence among the research problem, the defined objectives and the proposed system of didactic actions for learning trigonometric ratios. Methods and techniques were therefore selected to enable an in-depth understanding of the difficulties faced by 11th-grade students at Sumbe High School.

Based on the theoretical premises presented in the previous chapter, it is necessary to describe the methodological procedures that guided the study, beginning with a characterization of the type of research conducted.

2.2 Type of Research

This study follows a qualitative approach supported by quantitative elements. The qualitative approach was chosen because it makes it possible to understand educational phenomena in their natural context by analysing the behaviours, perceptions and difficulties of participants involved in the teaching-learning process.

According to Creswell (2022), qualitative research seeks to understand the meanings, experiences and interpretations that individuals attribute to social and educational phenomena. In this study, this approach makes it possible to understand students' difficulties in learning trigonometric ratios and identify appropriate strategies for overcoming them.

The quantitative component, in turn, makes it possible to organize and interpret information obtained through tests, questionnaires and other data collection instruments, contributing to a more objective analysis of the results.

In terms of its objectives, the study is descriptive and propositional. It is descriptive because it seeks to characterize the observed reality and identify existing difficulties. It is propositional because it culminates in the development of a system of didactic actions intended to improve the learning of trigonometric ratios.

Defining the type of research is only one stage of the methodological process. Carrying out the study also required the use of appropriate scientific methods.

2.3 Research Methods

Research methods represent the paths used to achieve the defined scientific objectives. Theoretical and empirical methods were used in this study.

2.3.1 Theoretical Methods

Analysis and Synthesis: This method made it possible to study the literature related to Didactics, meaningful learning, Mathematics teaching and trigonometric ratios. Analysis made it possible to break the content down into its fundamental parts, while synthesis allowed knowledge to be integrated coherently.

Induction and Deduction: Induction made it possible to proceed from observing particular situations to formulating generalizations. Deduction allowed general knowledge of Didactics and Mathematics Education to be applied to the specific reality of Sumbe High School.

Historical-Logical Method: This method contributed to understanding the development of conceptions related to Mathematics teaching and the methodologies used in learning trigonometric ratios.

2.3.2 Empirical Methods

Observation: Observation made it possible to monitor students' behaviour during lessons, identifying difficulties, forms of participation and strategies used to solve mathematical problems.

Questionnaire: The questionnaire was administered to students to collect information related to their difficulties, perceptions and attitudes toward learning trigonometric ratios.

Interview: The interview was conducted with Mathematics teachers and made it possible to collect opinions on students' difficulties and the strategies used in teaching Trigonometry.

Document Analysis: This method made it possible to analyse curricular programmes, lesson plans, pedagogical reports and other documents related to Mathematics teaching.

The use of these methods made it possible to obtain diverse and complementary information. However, to ensure the validity of the results, it was necessary to clearly define the population and sample of the study.

2.4 Population and Sample

The population corresponds to the set of elements that share characteristics relevant to the study. In this case, the population consists of 11th-grade students and Mathematics teachers at Sumbe High School.

The sample was selected intentionally, considering participants' availability and their direct relationship with the phenomenon studied. Choosing this sample made it possible to collect information relevant to understanding the problem under investigation.

Defining the population and sample made it possible to identify the research subjects. Next, it was necessary to select appropriate instruments for data collection.

2.5 Data Collection Techniques and Instruments

Different techniques and instruments were used to collect data, allowing for a more comprehensive analysis of the reality under investigation.

Diagnostic Test: Administered to students to assess their prior knowledge of right triangles, angles and trigonometric ratios.

Observation Guide: Used during lessons to record behaviours, levels of participation and difficulties experienced by students.

Questionnaire: Composed of open- and closed-ended questions related to learning trigonometric ratios.

Interview Guide: Addressed to Mathematics teachers to collect information on pedagogical practices, observed difficulties and strategies used.

The data collected through these instruments provided a foundation for the intervention proposal presented in the following chapter.

2.6 Data Processing Procedures

The data obtained were organized, classified and interpreted in accordance with the study's objectives.

Qualitative information was examined through content analysis, making it possible to identify categories related to learning difficulties and the pedagogical practices used.

Quantitative data were organized in tables and percentages, facilitating interpretation of the results and identification of the main trends observed.

In summary, the methodological procedures adopted ensured that relevant information was obtained for understanding the problem under investigation. Based on these results, it was possible to develop a pedagogical intervention proposal suited to the context of Sumbe High School.

CHAPTER III – SYSTEM OF DIDACTIC ACTIONS FOR LEARNING TRIGONOMETRIC RATIOS

3.1 Presentation of the Proposal

The theoretical and methodological analysis carried out throughout the study demonstrated the need to implement pedagogical strategies capable of improving the learning of trigonometric ratios among 11th-grade students at Sumbe High School.

Based on the results obtained, a system of didactic actions grounded in the principles of meaningful learning, active methodologies and student participation in the knowledge-construction process is proposed.

The system was designed in an integrated manner, considering the difficulties identified, curricular objectives and student characteristics.

3.2 Objective of the Proposal

To improve the learning of trigonometric ratios through the implementation of didactic actions that promote conceptual understanding, problem solving and the practical application of mathematical knowledge.

3.3 Proposed Didactic Actions

Action 1 – Diagnosis of Prior Knowledge

Objective: To identify students' knowledge and difficulties before introducing the content.

Activities:

Administration of a diagnostic test.

Collective discussion of the results.

Identification of the most frequent difficulties.

Action 2 – Use of Visual and Manipulative Resources

Objective: To facilitate understanding of trigonometric concepts.

Activities:

Construction of right triangles.

Use of posters and geometric figures.

Exploration of graphical representations.

Action 3 – Solving Contextualized Problems

Objective: To relate the content to real-life situations.

Activities:

Determining the height of trees.

Calculating the height of buildings.

Measuring inaccessible distances.

Action 4 – Cooperative Learning

Objective: To promote collaboration among students.

Activities:

Group work.

Discussion of solution strategies.

Collective presentation of the results.

Action 5 – Integration of Educational Technologies

Objective: To make teaching more interactive and motivating.

Activities:

Use of a scientific calculator.

Exploration of GeoGebra.

Digital simulations.

Action 6 – Continuous Formative Assessment

Objective: To monitor students' progress.

Activities:

Practical exercises.

Worksheets.

Self-assessment and peer assessment.

3.4 Expected Results

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The implementation of this system of didactic actions is expected to result in:

Better understanding of the concepts of sine, cosine and tangent;

Reduced learning difficulties;

Increased student participation in lessons;

Improved academic performance;

Development of problem-solving skills;

Greater motivation to study Mathematics.

3.5 Evaluation of the Proposal

The proposal should be evaluated continuously by observing student performance, analysing results obtained in exercises and comparing the results of the initial diagnosis with those of the final assessment.

Continuous monitoring will make it possible to introduce necessary adjustments and ensure the effectiveness of the actions implemented.

3.6 Chapter Summary

This chapter presented a system of didactic actions designed to respond to the difficulties identified in learning trigonometric ratios. The proposal is grounded in the principles of meaningful learning and active methodologies and seeks to promote teaching that is more participatory, contextualized and effective.

Implementing these actions may significantly contribute to improving the Mathematics teaching-learning process at Sumbe High School. Based on the expected results and the theoretical foundations presented, the following chapter sets out the study's conclusions, recommendations and references.

CHAPTER IV – RESULTS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 Research Results

Analysis of the data collected through observation, questionnaires, interviews and diagnostic tests made it possible to identify a set of difficulties that influence 11th-grade students' learning of trigonometric ratios at Sumbe High School.

The results showed that a significant proportion of students have difficulty identifying the elements of a right triangle, particularly distinguishing between the legs and the hypotenuse. This limitation is an initial obstacle to understanding trigonometric ratios because calculating sine, cosine and tangent depends on correctly identifying the sides of the triangle.

It was also found that many students have difficulty interpreting the mathematical problems presented in lessons and assessments. In several cases, students know the trigonometric formulas but cannot identify which one should be used in each specific situation.

Another aspect identified concerns the limited contextualization of content. Students showed greater interest when exercises were associated with everyday situations, such as determining the height of trees, buildings, lighting poles or mountains. This finding demonstrates the importance of connecting mathematical content with students' lived reality.

The teachers interviewed also reported that insufficient didactic resources and limited time for developing the content hinder the implementation of more participatory methodologies. Despite these limitations, they acknowledged that the use of practical activities and technological resources fosters understanding of trigonometric concepts.

The results obtained reinforce the need to implement a system of didactic actions that values students' active participation, the contextualization of content and the use of diversified resources.

The data analysed not only make it possible to understand the existing difficulties but also provide important elements for discussing the effectiveness of the strategies proposed in this study.

4.2 Discussion of the Results

The results obtained correspond with several studies conducted in the field of Mathematics Education. The specialized literature demonstrates that the difficulties observed in learning trigonometric ratios are not an isolated phenomenon but a recurring challenge in different educational contexts.

According to Moreira (2021), meaningful learning occurs when students can relate new knowledge to previously existing cognitive structures. This perspective helps explain the

difficulties observed because many students have gaps in the fundamental geometric knowledge needed to learn Trigonometry.

The observations made during the study showed that the use of contextualized examples helps increase students' motivation and facilitate understanding of the content. This result confirms the principles advocated by active teaching methodologies, which value student participation in constructing knowledge.

Similarly, the results support Libâneo's (2023) conclusions that teachers should assume the role of learning mediators by creating situations that foster discovery, investigation and problem solving.

The proposed system of didactic actions presented in this study seeks precisely to respond to these requirements by integrating visual resources, cooperative activities, contextualized problem solving and educational technologies. These strategies are compatible with contemporary pedagogical guidelines and can contribute to significantly improving the learning of trigonometric ratios.

In addition, valuing formative assessment makes it possible to continuously monitor students' progress, identify difficulties and adjust pedagogical strategies whenever necessary. This practice fosters learning that is more personalized and centred on students' needs.

The discussion demonstrates that implementing an organized system of didactic actions is a viable alternative for improving the quality of Mathematics teaching at Sumbe High School. Based on these reflections, the main conclusions of the study are presented below.

CONCLUSIONS

This study aimed to propose a system of didactic actions to improve the learning of trigonometric ratios among 11th-grade students at Sumbe High School, Cuanza-Sul Province, Angola.

The literature review made it possible to understand the theoretical foundations related to Didactics, meaningful learning, Mathematics teaching and the difficulties frequently observed in learning Trigonometry. The studies analysed demonstrated that students' active participation and the contextualization of content are determining factors in successful learning.

The research results showed that many students have difficulties identifying the elements of a right triangle, understanding trigonometric ratios and solving mathematical problems. These limitations negatively affect academic performance and compromise the acquisition of the competencies set out in the 11th-grade curriculum.

The analysis led to the conclusion that the predominant use of traditional methodologies, together with the limited contextualization of content, is one of the factors contributing to the observed difficulties.

Based on the results obtained, a system of didactic actions grounded in the principles of meaningful learning and active methodologies was developed. The proposal includes diagnostic activities, the use of visual resources, contextualized problem solving, cooperative learning, the integration of educational technologies and continuous formative assessment.

It is concluded that implementing this system of didactic actions may contribute significantly to improving the learning of trigonometric ratios by promoting greater student participation, strengthening conceptual understanding and improving academic performance.

Consequently, the research hypothesis is considered confirmed: the use of appropriate didactic strategies fosters meaningful learning of trigonometric ratios among 11th-grade students at Sumbe High School.

The conclusions reached make it possible to formulate recommendations for teachers, school administrators and researchers interested in improving Mathematics teaching.

RECOMMENDATIONS

Based on the research results, the following recommendations are made:

For Mathematics teachers:

- Use active methodologies that promote student participation.
- Contextualize trigonometric content through everyday situations.
- Integrate technological resources and manipulatives into lessons.
- Strengthen formative assessment throughout the teaching-learning process.

For the administration of Sumbe High School:

- Promote continuing education activities for Mathematics teachers.
- Encourage the acquisition of didactic and technological resources.
- Support practical activities related to Mathematics.

For the Ministry of Education:

- Strengthen teacher training programmes focused on innovative methodologies.
- Provide specific didactic materials for teaching Trigonometry.
- Encourage the use of educational technologies in secondary schools.

For future researchers:

- Conduct studies on the impact of digital technologies on Mathematics learning.

- Investigate the effectiveness of active methodologies in other areas of Mathematics.
- Conduct similar studies in different Angolan educational contexts.

The recommendations presented seek to contribute to improving pedagogical practices and the quality of Mathematics teaching in Angola.

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