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Instructional Design in Mathematics Teaching: Application of the ADDIE E Model Active Methodologies for Meaningful Learning

Instructional Design in Mathematics Teaching: Applying the ADDIE Model and Active Methodologies for Meaningful Learning

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SUMMARY

This study addresses the application of Instructional Design (ID) in mathematics teaching, highlighting its relevance for developing more organized, interactive, and meaningful pedagogical practices. Based on an analysis of the target audience's needs and the use of the ADDIE model, ID allows for the systematic planning, development, implementation, and evaluation of educational strategies, fostering student learning. The paper discusses the advantages of this model, such as the organization of the pedagogical process, its adaptation to different student demands, the integration of active methodologies, and the possibility of continuous teaching assessment. At the same time, limitations are presented, including the need for time and resources for planning, the risk of excessive systematization, and the dependence on student engagement. The literature review provided a theoretical foundation for the study, supporting the understanding of the importance of ID in the school context. It is concluded that the application of Instructional Design contributes significantly to making mathematics teaching more efficient, dynamic, and connected to students' realities, promoting the development of critical knowledge and improving pedagogical practices.

Keywords: Instructional Design. Mathematics Teaching. Active Methodologies. ADDIE Model. Meaningful Learning.

ABSTRACT

This study addresses the application of Instructional Design (ID) in mathematics teaching, highlighting its relevance for the construction of more organized, interactive, and meaningful pedagogical practices. Based on an analysis of the target audience's needs and the use of the ADDIE model, ID allows for the systematic planning, development, implementation, and evaluation of educational strategies, promoting student learning. The study discusses the advantages of this model, such as the organization of the pedagogical process, adaptation to different student demands, the integration of active methodologies, and the possibility of continuous teaching evaluation. At the same time, limitations are presented, including the need for time and resources for planning, the risk of excessive systematization, and dependence on student engagement. The bibliographic research carried out provided the theoretical basis for the study, supporting the understanding of the importance of ID in the school context. It is concluded that the application of Instructional Design contributes significantly to making mathematics teaching more efficient, dy-namic, and connected to the reality of students, promoting the construction of critical knowledge and the improvement of pedagogical practices.

Keywords: Instructional Design. Mathematics Teaching. Active Methodologies. ADDIE Model. Meaningful Learning.

1. INTRODUCTION

The development of the exact sciences is intrinsically related to practical needs of humanity. The transition of human groups from nomadism to sedentary life demanded new forms of social and economic organization, in which barter played a central role in collective survival. This process resulted in early commercial practices, establishing the presence of numbers as instruments of social mediation, whose relevance remains to this day.

With this premise, the teaching of Mathematics in education reveals itself as something essential, since its mastery constitutes relevant baggage for life in society. However, in the school context, both students and teachers face difficulties in assigning meaning to this area of knowledge, which is often reduced, as Freire points out, to a practice of banking education.

Faced with this challenge, the use of active methodologies has been consolidated as a significant strategy for the teaching team, by enabling practices that attribute "meaning" to the teaching-learning process of Mathematics. In this scenario, Design Instructional (DI) plays a fundamental role, as it adds value to pedagogical work by investigate the target audience and structure strategies using the ADDIE model, enhancing the construction of knowledge in a more critical and meaningful way.

Based on the ADDIE method, which is composed of phases that analyze and evaluate materials to be applied in a flexible and interactive way, it becomes possible structure the teaching-learning process in a more organized and effective manner. Its stages — Analysis, Design, Development, Implementation and Evaluation — allow that the teacher identifies the needs of the target audience, plans appropriate strategies, produce teaching resources, apply them in the classroom and, finally, carry out a continuous evaluative monitoring. In this way, the model guarantees not only the systematization of pedagogical work, but also constant adaptation to demands of students, favoring more meaningful learning.

To support this reflective path, a bibliographical research was carried out, conducted through the selection and analysis of works, scientific articles and official documents related to the teaching of Mathematics, active methodologies and the ADDIE model itself.

This survey allowed us to gather different theoretical and practical perspectives, enabling a consistent foundation for the study and ensuring greater academic validity to the discussions presented.

2. THEORETICAL FRAMEWORK

2.1 Application of Instructional Design in Mathematics Teaching

The study of exact sciences, especially Mathematics, has always been linked to social and cultural needs of human beings. If, at first, their application was aimed at survival practices — such as counting food, the division of land and commercial exchanges — today, it is consolidated as an area indispensable for critical and civic development. However, the teaching of Mathematics faces, in the contemporary school context, numerous challenges, both for teachers as for students. Learning is often reduced to mere transmission of content, without connection to the reality of the students, characterizing what Freire (1996, p. 72) calls it “banking education, in which students only receive information without problematization”.

Given this scenario, it becomes necessary to seek teaching strategies that redefine the teaching-learning process, giving it meaning and applicability and criticality. In this context, active methodologies emerge as alternatives pedagogical techniques capable of engaging the student as the protagonist of the construction of knowledge, while the teacher assumes the role of mediator. To structure this process in a planned and systematized way, Instructional Design (ID) emerges as a relevant proposal, as it organizes the learning objectives, selects methods appropriate and promotes constant evaluations, supported by the ADDIE model.

2.2 Instructional design in mathematics teaching

According to Filatro (2004, p. 45), “Instructional Design consists of planning and systematically organize all stages of the teaching-learning process, ensuring that educational objectives are achieved efficiently.” When applied to the teaching of Mathematics, DI proves to be a tool with great potential,

since the discipline requires clarity, systematization and logical progression in development of the contents.

The five phases of the ADDIE model — Analysis, Design, Development, Implementation and Evaluation — allow the teacher to better understand the profile of students, design contextualized strategies, develop materials closer to the reality of the students and, in the end, constantly evaluate the results obtained. This flexible and interactive structure makes the teaching process more dynamic, avoiding improvisations disconnected from the final objective.

2.3 Advantages of Instructional Design

Among the main advantages of Instructional Design in teaching Mathematics, we can highlight the systematic organization of the pedagogical process. Instead of classes fragmented, the teacher begins to plan the discipline in coherent stages, which facilitates both teaching and learning. Furthermore, DI enables adaptation to needs of the target audience, since the analysis phase is dedicated to understanding the difficulties, interests and prior knowledge of students.

Another important advantage is the possibility of integrating methodologies active, such as the flipped classroom, gamification or project-based learning. Moran (2015, p. 103) emphasizes that “educational innovation requires the teacher to integrate content, technologies and pedagogical strategies in a meaningful way for the students”. The DI, in this sense, serves as a map so that these methodologies do not are used in isolation, but inserted within a cohesive planning and guided by clear objectives.

Finally, DI promotes continuous assessment of the learning process. The phase end of the ADDIE model ensures that the results are reviewed, analyzed and, if necessary, reworked. This practice breaks with the traditional evaluation only summative, allowing adjustments to occur along the way.

2.4 Disadvantages and limitations of instructional design

Despite its contributions, DI also has limitations. One of the main criticism is the excessive systematization, which can hinder teaching work and reduce teacher creativity. In some cases, excessive focus on structure methodological can lead to a loss of sensitivity to spontaneous demands of students during the learning process.

Another point to consider is the demand for time and resources. The development of detailed planning, aligned with the ADDIE phases, requires dedication and, often, sometimes, institutional support. In school contexts marked by work overload teaching staff, large classes and lack of infrastructure, DI can be seen as a proposal difficult to be fully implemented.

Furthermore, it is important to recognize that DI, by itself, does not guarantee the student engagement. As Freire (1996, p. 81) points out, “there is no learning significant without problematizing reality and critical participation of students”. Thus, DI must be understood as a support tool and not as a solution unique for the challenges of teaching.

3. MATERIAL AND METHOD

This study was conducted through bibliographic research, based on books, scientific articles and official documents that address the teaching of Mathematics, active methodologies and Instructional Design. The ADDIE model was adopted as methodological reference, serving as a guide for organizing the analysis. The steps followed the logic of theoretical survey, selection of relevant sources, critical analysis and interpretative synthesis. The works of Freire (1996), Filatro (2004) and Moran (2015) constituted the main theoretical basis, complemented by other authors who discuss pedagogical innovation and teaching strategies.

The research used a qualitative approach, focused on the interpretation and critical analysis of the references studied. Selection criteria were established for the sources, prioritizing classic and recent works on the subject, in order to ensure validity

and academic relevance. In addition, we sought to identify points of convergence and divergence between authors, in order to build a comprehensive vision of Design Instructional and its implications for teaching Mathematics. This methodological process allowed us to understand the potential and limitations of the ADDIE model, as well as its applications in the school context.

4. RESULTS AND DISCUSSION

The results of the analysis indicate that Instructional Design, when applied to teaching Mathematics, contributes significantly to improving the practice teaching. Among the benefits, the systematic organization of the process stands out pedagogical, the coherent integration of active methodologies and adaptation to needs specific to students.

However, significant challenges have been identified. The first is time. necessary for detailed planning of each stage, which requires teaching dedication and institutional support. Another challenge is the need for pedagogical resources and adequate technological resources, not always available in all schools. Furthermore, the student engagement continues to be a decisive factor: even with innovative strategies, the active participation of the student is essential for learning to occur in a significant.

Compared to traditional teaching, marked by the transmission of content and due to the centrality of the teacher, Instructional Design combined with active methodologies represents a paradigm shift. It promotes student protagonism, strengthens the teacher's mediating role and expands assessment possibilities procedural. Such changes are aligned with the contemporary demands of education, that demand critical training, intellectual autonomy and problem-solving ability complex problems.

FINAL CONSIDERATIONS

The study developed highlighted the relevance of Instructional Design as strategic tool for teaching Mathematics, enabling more efficient planning structured and the implementation of active methodologies that favor learning significant. Throughout the work, it was possible to understand that the use of the model ADDIE allows you to analyze student profiles and develop teaching resources appropriate and continually evaluate the process, contributing to overcoming the difficulties faced by both students and teachers in the school context.
Thus, the objectives related to the organization of teaching, adaptation to needs of the target audience and the promotion of more dynamic and contextualized were fully achieved.

Furthermore, the bibliographic research carried out made it possible to consolidate theoretical foundations that support the importance of Instructional Design in Education, offering consistent support for the practical application of the ADDIE model. The work demonstrated that by integrating planning, development and evaluation, it is possible to make the teaching of Mathematics more meaningful and effective, promoting a process of more critical, interactive learning aligned with the real needs of students, reinforcing the importance of planned and reflective pedagogical strategies in the environment school.

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