IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 16, Issue 1 Ser. 2 (Jan. – Feb. 2026) 60-64
www.iosrjournals.org

Digital Technologies And The Overcoming Of Difficulties In Mathematical Learning

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Abstract:
Difficulties in mathematical learning remain a historical challenge in the context of Basic Education and are related to pedagogical, training, curricular, and sociocultural factors. This article discusses how digital technologies can contribute to overcoming these difficulties, based on a theoretical analysis grounded in recent studies in Mathematics Education. Initially, reflections are presented on the historical constitution of learning difficulties in Mathematics, highlighting school practices marked by technical centrality, conceptual fragmentation, and the distancing between school content and students' social contexts. Subsequently, the pedagogical foundations that support proposals aimed at meaningful learning are discussed, with emphasis on the role of teacher mediation, formative assessment, and problem solving as structuring elements of teaching. Next, the potential of digital technologies as mediators of mathematical learning is analyzed, especially in contents that require visualization, interaction, and experimentation, such as Geometry. It is shown that the intentional use of these technologies favors the construction of meanings, broadens student participation, and enables more active and collaborative learning paths. It is concluded that overcoming difficulties in mathematical learning requires reflective pedagogical practices, continuous teacher education, and critical integration of digital technologies, understood as a constitutive part of teaching and learning processes.
Keywords: *Mathematical learning; Digital technologies; Learning difficulties; Teacher mediation.*

Date of Submission: 25-01-2026 Date of Acceptance: 05-02-2026

I. Introduction

The challenges affecting the quality of Mathematics teaching and learning are multifaceted and encompass structural, pedagogical, and training-related aspects. From the teachers' perspective, insufficient continuing education, workload overload, and precarious material conditions in schools emerge as factors that strain daily school life and limit the implementation of more reflective and contextualized pedagogical practices. Added to this is teachers' perception of students' fragile prior knowledge, as well as issues related to indiscipline and lack of student interest, elements that directly impact the construction of mathematical concepts (Silva & Santos, 2020). From the students' perspective, difficulties in assimilating content and the lack of mastery of knowledge considered prerequisites reinforce the understanding that mathematical learning occurs cumulatively and depends on solid conceptual foundations, which are often not consolidated throughout the school trajectory.

In this scenario, the teacher's role becomes central, especially regarding pedagogical mediation and the conduct of classroom practices. By fostering discussions, encouraging argumentation, and valuing different problem-solving strategies, teachers create conditions for students to make their reasoning explicit and construct meanings around the Mathematics involved in proposed situations. Research indicates that practices restricted to checking correct answers and reproducing calculations significantly reduce the formative potential of mathematical activities, as they neglect the exploration of meanings, conceptual connections, and cognitive processes mobilized by students (Allevato et al., 2024). Thus, Mathematics teaching requires spaces for dialogue and reflection that go beyond the procedural dimension.

Learning assessment, understood as a constitutive part of pedagogical work, is also included in this debate as a fundamental element for advancing mathematical learning. When conceived simultaneously as assessment for and as learning, it ceases to serve only a classificatory function and assumes an investigative and diagnostic character. From this perspective, errors, questioning, and students' written or pictorial records gain relevance, as they allow teachers to access the cognitive paths taken during task resolution. Such an evaluative approach contributes to understanding students' ways of thinking and provides support for more consistent pedagogical interventions aligned with real learning needs (Teixeira & Moreira, 2022).

These discussions directly dialogue with the assumptions of the Theory of Meaningful Learning (TML), which highlights the importance of prior knowledge in the construction of new meanings. Recent literature reviews show the wide adoption of this theory in the field of Mathematics teaching and learning in Basic Education, with significant scientific production in recent years, especially in Brazilian journals. The concentration of studies in different international databases points to the recognition of TML as a consistent theoretical framework capable of supporting pedagogical proposals that value the relationship between prior knowledge, new content, and learning contexts (Huf et al., 2024). In this sense, the articulation between teacher mediation, formative assessment practices, and the theoretical foundations of meaningful learning emerges as a promising path to address the historical challenges of Mathematics teaching.

II. Difficulties In Mathematical Learning: Historical And Pedagogical Aspects

Difficulties in mathematical learning have consolidated as a broad and consistent field of investigation within Mathematics Education. Research indicates that such difficulties are not manifested merely in the absence of correct answers but are expressed, above all, in the strategies mobilized by students when facing proposed tasks. In many cases, students resort to inefficient procedures or apply techniques mechanically and indiscriminately, even when these are not appropriate to the situation at hand. This strategic rigidity reveals limitations in the development of mathematical thinking and compromises more adequate decision-making during problem solving, producing negative impacts on learning outcomes (Masola & Allevato, 2019).

These difficulties must be understood in light of the historical constitution of Mathematics as school knowledge. Although Mathematics emerged in Antiquity from concrete needs of everyday life, its schooling over time ended up distancing it from the social contexts that gave rise to it. Inserted into the curriculum as a central discipline, Mathematics came to assume a normative and abstract character, often disconnected from students' experiences. This historical configuration contributed to teaching practices marked by the transmission of procedures and excessive valorization of technique, reinforcing learning obstacles and limiting students' construction of meanings (Kuhn, 2020).

In this context, diagnostic assessment assumes a strategic role in addressing difficulties in mathematical learning. By enabling teachers to identify what students have learned and which knowledge has not yet been consolidated, assessment ceases to be merely a measurement instrument and begins to guide pedagogical planning. When conceived as part of an investigative process, assessment contributes to didactic interventions that are more coherent with students' needs, respecting their singularities and promoting an active path of mathematical knowledge construction (Neres et al., 2022).

Moreover, contemporary discussions have problematized the way the history of Mathematics is traditionally presented in schools. A predominantly Eurocentric and colonial perspective has sustained specific ways of teaching the discipline, reinforcing its image as neutral, distant, and hardly accessible knowledge. This restricted historical perspective contributes to student disengagement and hinders meaning attribution to mathematical content (Oliveira, 2024). By incorporating critical historical approaches into teaching, it becomes possible to present Mathematics as a human construction situated in diverse sociocultural contexts, fostering more reflective and meaningful pedagogical practices.

Thus, the dialogue between learning difficulties, assessment processes, and historical aspects of Mathematics points to the need to rethink Mathematics teaching. Integrating strategies that value the diversity of reasoning, formative diagnostic assessments, and a contextualized historical approach can contribute to overcoming mechanistic practices and promoting more meaningful and socially situated mathematical learning.

III. Mathematical Learning Mediated By Technologies

The increasingly intense presence of digital technologies in students' daily lives has brought about significant shifts in the ways of teaching and learning Mathematics. In the field of Geometry, the integration of digital resources makes it possible to overcome traditionally static approaches, favoring the exploration of a dynamic, interactive, and visual geometry. Recent studies indicate that the use of digital technologies in teaching geometric content, such as triangles, enhances student participation and stimulates meaning construction through the manipulation and experimentation of mathematical objects in digital environments. In addition, these studies play a formative role by offering teachers concrete examples of pedagogical practices developed by their peers, contributing to professional development and the re-signification of Geometry teaching (Gumiero & Pazuch, 2024).

In this sense, the professional development of Mathematics teachers is a central element for the effective integration of digital technologies into the teaching–learning process. Such development should be anchored in diversified and contextualized experiences involving investigation, planning, practice, and reflection on pedagogical action itself. Teachers, as agents directly involved in curriculum construction, need to articulate official curricular guidelines with the methodological possibilities offered by digital technologies. Considering that Information and Communication Technologies are part of contemporary daily life, their insertion into educational practices requires continuing education that promotes critical reflection on different types of learning activities and their applicability in the classroom (Sampaio & Coutinho, 2015).

The need to integrate technologies into teaching became even more evident during the Covid-19 pandemic. Emergency remote teaching imposed on teachers the challenge of reformulating methodologies and teaching instruments, adapting them to online instruction within a short time frame. This scenario highlighted both the potential of digital technologies for maintaining educational processes and the structural and training-related weaknesses of the educational system, especially regarding teacher preparation for the pedagogical use of digital tools (Paulo & Lucas, 2022).

From this perspective, digital technologies come to be understood not merely as support instruments but as mediators of the mathematical learning process. By enabling the creation and resolution of problems in interactive environments, these tools foster new forms of interaction between teachers and students, promoting more active and collaborative learning. Technology-mediated interaction expands possibilities for mathematical knowledge construction by allowing students to explore concepts, test hypotheses, and discuss different problem-solving strategies (Lima & Rocha, 2022).

Empirical research results reinforce that the incorporation of digital technologies can positively impact students' motivation and understanding in Mathematics. The use of educational software, such as GeoGebra, as well as gamified platforms, has shown promise in addressing both students with learning difficulties and those with greater content mastery, favoring more individualized learning paths. However, these benefits are directly conditioned by teacher education and the availability of technological infrastructure in educational institutions—factors that still constitute obstacles to consolidating pedagogical practices mediated by digital technologies (Almeida & Andresen, 2024).

Thus, the dialogue among studies shows that technology-mediated mathematical learning requires not only access to digital resources but, above all, the construction of reflective pedagogical practices supported by continuous teacher education, adequate structural conditions, and didactic intentionality. The critical integration of digital technologies into Mathematics teaching therefore emerges as a powerful path to promoting more meaningful learning, especially in content areas that benefit from visualization, interaction, and experimentation, such as Geometry.

IV. Overcoming Difficulties In Mathematical Learning

The understanding of Mathematics as school knowledge historically marked by selective and exclusionary practices has been widely problematized in Mathematics Education research. In this debate, the need to re-signify the role of Mathematics in subject formation stands out, overcoming its social function as a filter and assuming it as a tool for critical understanding of the world and intellectual emancipation. Such a shift in perspective implies rethinking pedagogical practices, curricula, and educational policies, especially regarding content contextualization, digital technology integration, and the adoption of active methodologies as strategies capable of promoting deeper and socially relevant learning (Bernardo, 2025).

This conception directly dialogues with approaches that understand mathematical learning as a process mediated by activity. By assuming that the development of thinking is not limited to technical mastery of "knowing how to do" but involves conscious appropriation of mathematical concepts, the importance of didactic proposals guided by teaching activity becomes evident. In this context, students, by engaging in situations that demand reflection, analysis, and generalization, develop more elaborate modes of thinking, such as functional algebraic thinking. These processes reveal movements of personal meaning production that contribute to overcoming learning gaps originating from school trajectories marked by conceptual voids (Ferreira & Virgens, 2024).

However, for such development to materialize, it is necessary to problematize pedagogical practices that present mathematical concepts and procedures in a decontextualized manner, assuming that students alone can abstract and apply them in problem-solving situations. Research indicates that mere content exposition does not guarantee mathematical knowledge construction. In this sense, proposals that use problems as structuring elements of learning must go beyond their instrumental function, articulating problem solving with the conceptual and procedural construction of mathematical content. The “problem for content application” approach can be re-signified when integrated into processes that favor understanding concepts in their genesis and multiple relationships (Proença et al., 2022).

This discussion finds support in the very nature of Mathematics as a science. Although characterized by a high level of abstraction and a complex formal language, Mathematics constitutes a fundamental reference for understanding natural phenomena and producing explanatory models of the world. Understanding these models, when mediated by pedagogical practices that value meaning and significance, awakens interest, expectation, and involvement in both those who teach and those who learn. Thus, mathematical learning can assume a mobilizing character, capable of provoking intellectual enchantment and strengthening the knowledge construction process (Pontes, 2019).

Thus, the dialogue among these authors points to the need for Mathematics teaching that articulates emancipation, activity, problem solving, and conceptual understanding. This perspective demands pedagogical practices that recognize students as active subjects of the learning process, promote intentional teacher mediation, and value strategies that bring mathematical knowledge closer to meaningful contexts. By assuming this commitment, Mathematics teaching can effectively contribute to guaranteeing all students’ right to meaningful, critical, and socially situated learning (Mazzaro et al., 2022; Junger et al., 2023; Junger et al., 2025).

V. Conclusion

The discussions developed throughout this study demonstrate that difficulties in mathematical learning are not restricted to individual student limitations but result from a set of historical, pedagogical, and institutional factors that permeate teaching organization. Practices centered on procedure reproduction, excessive valorization of technique, and disconnection of mathematical content from sociocultural contexts contribute to the construction of less meaningful teaching, reinforcing conceptual gaps throughout the school trajectory.

In this scenario, teacher mediation, articulated with diagnostic and formative assessment processes, plays a decisive role in re-signifying mathematics teaching. Valuing prior knowledge, students’ diverse ways of thinking, and problem solving as a structuring axis of learning favors meaning construction and expands possibilities for student participation. This perspective dialogues with theoretical frameworks that understand learning as an active, situated, and mediated process in which error and questioning constitute elements of mathematical thinking development.

The integration of digital technologies fits into this movement as a concrete possibility for reorganizing pedagogical practices. When supported by didactic intentionality, teacher education, and adequate structural conditions, these technologies expand forms of interaction, visualization, and mathematical experimentation, contributing to more meaningful learning. Thus, overcoming difficulties in mathematical learning requires a collective commitment to critical, reflective, and socially situated pedagogical practices capable of guaranteeing all students’ right to mathematical knowledge construction.

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