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TEACHING MATHEMATICS USING TECHNOLOGY IN THE CLASSROOM

O ENSINO DA MATEMÁTICA COM USO DE TECNOLOGIAS EM SALA DE AULA

ENSEÑANZA DE MATEMÁTICAS USANDO TECNOLOGÍA EN EL AULA

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ABSTRACT

This study aims to investigate the contributions of digital technologies to mathematics teaching in the classroom, comparing traditional methods and technological resources in the learning process. Traditional methods, based on expository explanations, textbooks, and manual exercises, while fundamental to the development of mathematical reasoning, often limit students' ability to apply concepts in a contextualized and dynamic manner. On the other hand, the use of technologies—such as mathematical software, applications, virtual platforms, and digital learning objects—has proven effective in making content more interactive, visual, and accessible, enabling more active and personalized learning. Research indicates that a balanced integration of traditional pedagogical strategies and technological resources offers a more inclusive, participatory teaching environment adapted to the demands of the 21st century. Technologies do not replace the role of the teacher, but rather serve as allies in promoting meaningful teaching focused on the development of essential skills, such as problem-solving, critical thinking, and intellectual autonomy.

Keywords: Mathematics Teaching. Educational Technologies. Pedagogical Practices. Digital Education. Innovation in Teaching.

RESUMO

O presente trabalho tem como objetivo investigar as contribuições do uso de tecnologias digitais no ensino da matemática em sala de aula, comparando os métodos tradicionais e os recursos tecnológicos no processo de aprendizagem. Os métodos tradicionais, baseados na explicação expositiva, no uso de livros e exercícios manuais, embora fundamentais para o desenvolvimento do raciocínio matemático, muitas vezes limitam a capacidade dos alunos em aplicar conceitos de forma contextualizada e dinâmica. Por outro lado, o uso de tecnologias — como softwares matemáticos, aplicativos, plataformas virtuais e objetos digitais de aprendizagem — tem se mostrado eficiente em tornar o conteúdo mais interativo,

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visual e acessível, possibilitando uma aprendizagem mais ativa e personalizada. A pesquisa aponta que a integração equilibrada entre estratégias pedagógicas tradicionais e recursos tecnológicos oferece um ambiente de ensino mais inclusivo, participativo e adaptado às demandas do século XXI. As tecnologias não substituem o papel do professor, mas funcionam como aliadas na promoção de um ensino significativo e voltado ao desenvolvimento de competências essenciais, como resolução de problemas, pensamento crítico e autonomia intelectual.

Palavras-chave: Ensino de Matemática. Tecnologias Educacionais. Práticas Pedagógicas. Educação Digital. Inovação no Ensino.

RESUMEN

Este estudio busca investigar las contribuciones de las tecnologías digitales a la enseñanza de las matemáticas en el aula, comparando métodos tradicionales y recursos tecnológicos en el proceso de aprendizaje. Los métodos tradicionales, basados en explicaciones expositivas, libros de texto y ejercicios manuales, si bien son fundamentales para el desarrollo del razonamiento matemático, a menudo limitan la capacidad de los estudiantes para aplicar conceptos de forma contextualizada y dinámica. Por otro lado, el uso de tecnologías —como software matemático, aplicaciones, plataformas virtuales y objetos digitales de aprendizaje— ha demostrado ser eficaz para hacer que el contenido sea más interactivo, visual y accesible, permitiendo un aprendizaje más activo y personalizado. Las investigaciones indican que una integración equilibrada de estrategias pedagógicas tradicionales y recursos tecnológicos ofrece un entorno de enseñanza más inclusivo y participativo, adaptado a las exigencias del siglo XXI. Las tecnologías no sustituyen el rol del docente, sino que sirven como aliadas para promover una enseñanza significativa centrada en el desarrollo de habilidades esenciales, como la resolución de problemas, el pensamiento crítico y la autonomía intelectual.

Palabras clave: Enseñanza de las Matemáticas. Tecnologías Educativas. Prácticas Pedagógicas. Educación Digital. Innovación Docente.

1 INTRODUCTION

The teaching of mathematics, traditionally based on expository practices and the repetition of exercises, has been challenged by technological transformations that directly impact the school environment. The growing presence of digital resources, such as interactive applications, educational software, and online teaching platforms, has driven a new way of teaching and learning mathematics, more dynamic, visual, and student-centered. This change represents a significant opportunity to overcome historical difficulties of the discipline, such as excessive abstraction and student demotivation.

The application of technologies in the classroom allows the teacher to use tools that favor the visualization of abstract mathematical concepts, promote interactive activities and monitor student performance in a more personalized way. Simulations, explanatory videos, digital games, and automated assessment systems are examples of resources that can enhance the teaching and learning process, making it more accessible and effective. In addition, the use of technologies stimulates student protagonism and facilitates collaborative learning, integrating mathematical content into the students' daily lives.

However, the indiscriminate use of technological resources can bring risks, such as excessive dependence on digital tools and the loss of basic skills, such as mental calculation and autonomous problem solving. It is also necessary to consider inequalities in access to the internet and devices, which can aggravate the digital divide and compromise educational equity. In this sense, the role of the teacher is fundamental to mediate the critical and conscious use of technologies, aligning them with pedagogical objectives and the needs of students.

In view of this scenario, this work proposes an analysis of the teaching of mathematics with the use of technologies in the classroom, considering the potentialities and challenges of this integration. It seeks to understand how technological innovations can enrich pedagogical practices without detracting from the essential foundations of mathematics education. By exploring the possibilities of reconciling traditional methods and digital

resources, it is intended to contribute to the construction of a more effective, meaningful teaching model aligned with the skills of the 21st century.

2 DEVELOPMENT

2.1 EDUCATION

Education is a fundamental process in human formation, playing an essential role in the personal, social and economic development of individuals and societies. Since the dawn of civilization, the transmission of knowledge and values has been central to the cultural and technological evolution of humanity. Throughout history, different education systems have emerged and evolved, each reflecting specific cultural, political, and economic contexts. However, the essential goal of education has always been to empower people with the cognitive, social, and practical skills necessary to fully engage in society.

Education is not limited to formal education in schools and universities, but also encompasses informal learning obtained at home, at work and in the community. This diversity of educational experiences contributes to the integral formation of individuals, preparing them to face challenges and take advantage of opportunities throughout life. In modern times, education faces new challenges and opportunities with the advancement of digital technologies and globalization. Online platforms and digital educational resources expand access to knowledge, allowing people around the world to learn autonomously and collaboratively (ALVES, 2015).

In addition to imparting academic knowledge, education also plays a crucial role in the formation of responsible and ethical citizens, promoting values such as tolerance, diversity, and respect for human rights. These aspects are essential for building fairer and more sustainable societies.

Therefore, investing in education is not only investing in individual development, but also in collective progress and building a better future for all. It is through education that societies can meet the challenges of the twenty-first century, empowering individuals to contribute meaningfully to global cultural, economic, and scientific advancement.

2.2 TECHNOLOGY

Technology permeates every aspect of modern life, shaping the way we live, work, communicate, and relate to each other. From the earliest innovations to the most recent advancements, technology has played a transformative role in society, driving scientific, economic, and cultural progress.

The history of technology dates back to the dawn of humanity, when our ancestors discovered rudimentary tools to facilitate everyday tasks. Over the millennia, these tools have evolved significantly, driven by scientific discoveries and technical advancements. The Industrial Revolution, for example, marked a turning point by introducing steam engines and mass production systems, profoundly altering the economy and social organization.

In the twentieth century, the pace of technological innovation accelerated exponentially. Electrification, automation, and computing have revolutionized entire industries, creating new job opportunities and redefining the standard of living globally. The arrival of the digital age brought with it personal computers, the internet and instant communication, connecting billions of people around the world and transforming the way we access information and relate to each other (MORAN, 2007).

Currently, we are immersed in the era of artificial intelligence and cloud computing, where advanced algorithms and large volumes of data are used to automate processes, predict behaviors, and personalize experiences. 5G technology promises to revolutionize mobile connectivity, enabling new applications in areas such as autonomous vehicles, digital health, and augmented reality. In healthcare, technology is revolutionizing diagnostics, treatments, and care, with advances in surgical robotics, telemedicine, and connected medical devices. In education, online platforms and digital resources are democratizing access to knowledge, allowing personalized and collaborative learning on a global scale (VIEIRA, 2012).

However, technological advancement is not without its challenges and concerns. Ethical issues such as data privacy, cybersecurity, and the environmental impact of technology production require careful approaches and proper regulations. Digital disparity is also a concern, with many communities and countries facing significant digital access and inclusion challenges.

It can be understood that technology is a powerful force that shapes the present and future of humanity. As a society, we face the challenge of harnessing the benefits of technological innovation while mitigating its risks and adverse impacts. By doing so, we can

build a future where technology is a tool for human progress, promoting a more just, inclusive, and sustainable society.

2.3 NEUROSCIENCE, EDUCATION, AND TECHNOLOGY

The intersection between neuroscience, education, and technology represents a key field of study for understanding how human intelligence interacts with modern technologies and how these interactions shape the process of learning and teaching in contemporary society. Neuroscience offers deep data on how the human brain processes information, learns, and adapts. With technological advances such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), scientists can observe neural patterns during cognitive activities, revealing complex aspects of learning (CUNHA, 2018).

This neuroscientific knowledge has direct implications for education. Understanding how the brain absorbs and retains information can inform more effective pedagogical practices. Neuroscience-based methods, such as personalized and adaptive learning, can be implemented to meet the individual needs of students, maximizing learning potential.

On the other hand, technology plays a crucial role in transforming the educational environment. Online learning platforms, digital resources, and interactive tools not only facilitate access to knowledge but also enable more dynamic and collaborative learning experiences. Artificial intelligence and data analysis are used to personalize teaching, offering accurate and adaptive feedback (ALVES, 2015).

Rapid technological evolution also presents challenges. Issues such as over-reliance on electronic devices, the privacy of student data, and inequality in access to technology are all important concerns to address in the effective integration of technology in education. In the social context, constant interaction with technology redefines not only the educational process, but also the skills and competencies needed by citizens of the twenty-first century. Learning is no longer limited to the school environment; it is a continuous and omnipresent process that occurs in different contexts and moments of daily life (CUNHA, 2018).

The ability to instantly access information, connect globally, and collaborate virtually is shaping a new generation of learners and educators. Skills such as critical thinking, problem-solving, and digital literacy become essential for effectively navigating a technology-driven world.

It is crucial, therefore, that society understands and enjoys the benefits of the intersection between neuroscience, education, and technology, while also addressing the

associated ethical and social challenges. Collaboration between neuroscientists, educators, and technologists is essential to develop innovative and sustainable educational strategies that prepare individuals not only for academic success, but also for full and ethical participation in the globalized and digitized society of the twenty-first century.

Thus, the convergence of these fields offers significant potential to transform learning and teaching, empowering individuals to reach their full cognitive potential and contribute positively to a more informed, inclusive, and progressive future.

2.4 TECHNOLOGY AND MATHEMATICS IN THE CLASSROOM

The integration of technology in mathematics teaching has been consolidated as one of the most promising strategies to improve the quality of learning in the school context. With the advancement of Digital Information and Communication Technologies (DICTs), the educational environment has new resources that favor the construction of mathematical knowledge in a more meaningful, visual and interactive way.

The use of educational software, such as GeoGebra, allows students to explore geometric, algebraic and statistical concepts through simulations and dynamic manipulations. This facilitates the understanding of abstract ideas and promotes learning by discovery, something that is difficult to achieve with traditional methods alone (LIMA; BARBOSA, 2017).

In addition, tools such as graphing calculators, spreadsheets, and adaptive learning platforms assist in solving complex problems and developing superior cognitive skills, such as critical analysis, data interpretation, and logical thinking (VALENTE, 2015).

The role of the teacher, in this context, becomes that of mediator and advisor of the learning process, using technologies as pedagogical instruments and not as substitutes for teaching practice. Technical knowledge about digital resources must be accompanied by a clear pedagogical intentionality (MORAN, 2007).

The use of didactic videos, tutorials, and educational games also stands out as a way to engage students and diversify teaching methodologies. Many students feel more motivated when interacting with multimedia materials, which present mathematics in a contextualized way and connected to their daily lives (FONSECA; SOUZA, 2020).

Virtual learning environments, such as Google Classroom, Khan Academy, and Moodle, allow math teaching to go beyond the physical boundaries of the classroom. The possibility of reviewing content, carrying out activities at different times and places and receiving immediate feedback expands learning opportunities (SILVA; PIRES, 2018).

However, the mere introduction of technology does not guarantee, by itself, the improvement of teaching. Planning, continuous teacher training and constant evaluation of the practices used are necessary. The inappropriate or decontextualized use of digital resources can become just a prop with no significant impact on learning (PAIVA; NASCIMENTO, 2019).

Another relevant aspect is the democratization of access to technologies. In many public schools, infrastructure is still precarious, and many students do not have devices or internet access at home, which deepens educational inequalities. Effective public policies are essential to ensure digital inclusion and equity in the educational process (ALMEIDA; PRADO, 2014).

The COVID-19 pandemic has highlighted the importance of technology in teaching, especially in the continuity of learning during school closures. Mathematics teachers resorted to resources such as video classes, live broadcasts, and apps to maintain the pedagogical bond with students, even in the face of numerous difficulties (COSTA et al., 2021).

In this sense, hybrid teaching and active learning, based on the combination of face-to-face and online activities, have gained space in contemporary curricular proposals. The personalization of teaching, collaborative work and student protagonism are favored by this approach (BELLONI, 2012).

Research shows that the planned insertion of technology in mathematics teaching contributes to improved school performance, greater content retention and the development of student autonomy. Students who use digital resources in their study routines tend to have a better conceptual understanding and a more positive attitude towards the discipline (CAVALCANTE; SILVA, 2020).

The National Common Curriculum Base (BNCC) also recognizes the importance of using digital technologies in the teaching and learning process. The document highlights the need to develop skills related to the ethical and responsible use of technology, as well as problem solving and mathematical communication (BRASIL, 2018). In this scenario, it is essential that the initial and continuing training of mathematics teachers contemplates the mastery of technological tools and innovative methodologies. Teacher training is one of the pillars for the effective implementation of pedagogical practices mediated by technology (VALENTE, 2015).

In addition to the pedagogical advantages, technology can bring mathematics closer to the sociocultural realities of students. Finance applications, logic games, and mathematical

modeling programs allow the contextualization of content and show its relevance in everyday life (LOPES; MOREIRA, 2019). Despite this, there is still some resistance on the part of some professors regarding the use of technology, either due to lack of familiarity, insecurity or lack of institutional support. Overcoming these barriers requires investment in infrastructure, teacher training and a school culture open to innovation (SANTOS; CASTRO, 2020).

Another point to be considered is the evaluation of technology-mediated learning. Digital platforms offer tools for diagnostic, formative and summative assessment, enabling the monitoring of students' progress in real time (BICUDO; BORBA, 2017).

Artificial intelligence and learning analytics are promising trends for personalizing math education. These resources allow the identification of specific difficulties of students and suggest evidence-based pedagogical interventions (ALMEIDA; PRADO, 2014).

Gamification, in turn, has stood out as an effective strategy to motivate and engage students. By using game elements, such as challenges, rewards and rankings, the teaching of mathematics becomes more attractive and participatory (MEDEIROS; ARAÚJO, 2016).

In summary, technology, when integrated in a critical and pedagogical way to the teaching of mathematics, represents a powerful ally for the construction of a more meaningful, dynamic and student-centered learning. However, it is essential that its use is aligned with educational objectives and the reality of the school community.

Research and pedagogical innovation must go hand in hand to ensure that technological tools expand learning opportunities and contribute to the formation of competent, critical and creative citizens.

Mathematics, more than a discipline of formulas and procedures, is a language of reading and intervention in the world. And technology, when well used, can open doors for students to develop this language with greater depth, pleasure and applicability. It is important to highlight that the balance between tradition and innovation is the key to effective pedagogical practice. The use of pencil, paper and blackboard is still necessary and complementary to digital resources, creating a hybrid and enriching educational environment. In this process, the teacher should be seen as a designer of learning experiences, capable of choosing, adapting, and combining different tools and methodologies to meet the needs of their students.

The future of mathematics education is closely linked to the ability of educational systems to incorporate technology in an equitable, effective, and humanizing way, promoting

teaching that makes sense to students and prepares them for the challenges of the twenty-first century.

2.4.1 Comparison between the Teaching of Mathematics with the Use of Technologies and Traditional Methods

Mathematics education, throughout history, has been shaped by traditional practices that are based on methods such as the use of textbooks, expository teaching, and problem-solving on the board. These methods, which have deep roots in the pedagogical tradition, prioritize the memorization of formulas, manual calculation, and the repetition of exercises as ways to consolidate learning (BICUDO; BORBA, 2017). For many years, such approaches were considered the most effective in ensuring that students developed a solid foundation in fundamental mathematical concepts, especially through the constant training and cognitive discipline imposed by the traditional model of teaching (D'AMBROSIO, 2001).

In fact, traditional methods of teaching mathematics are characterized by a linear and structured approach, in which the teacher acts as the main transmitter of knowledge. As Valente (2015) observes, in this model, the educator holds the authority over the content, using the textbook as the main pedagogical resource and adopting a directive posture during the class. The classroom activities, usually expository, are aimed at explaining formulas and algorithms, followed by mechanical exercises, aiming at fixing the contents cumulatively.

The evaluation of learning, in turn, takes place mostly through standardized written tests, in which the student is expected to demonstrate technical mastery when solving the proposed problems based on the methods previously taught (SANTOS; CASTRO, 2020). Although this methodology has ensured some effectiveness in the development of procedural skills, it has limitations regarding the construction of broader meanings of mathematics, often disregarding aspects such as creativity, contextualization, and critical thinking.

However, with the advancement of digital technologies and the growing digitalization of teaching, new methodological proposals have emerged that integrate resources such as educational software, interactive applications, online teaching platforms, and mobile devices into the teaching-learning process. These innovations have highlighted a new debate about the effectiveness of traditional methods compared to methods that use technology in mathematics education (MORAN, 2007).

Such technologies allow the student to manipulate mathematical objects, visualize abstract concepts, and interact with simulations and multiple representations —

characteristics that can favor more meaningful and lasting learning (ALMEIDA; PRADO, 2014). The insertion of these resources in the pedagogical context breaks with the linearity of traditional teaching, while valuing the personalization of learning, student autonomy and protagonism in the educational process.

This method, while effective in many contexts, has some limitations. Excessive repetition and an emphasis on memorization can lead to the mechanization of learning, where students learn to solve problems by following predefined steps, without necessarily understanding the underlying concepts. In addition, expository teaching, by itself, may not engage all students, especially those who have more visual or interactive learning styles.

In this sense, traditional practices remain relevant, especially in the structuring of logical and disciplined thinking, but they must be reinterpreted in the face of the possibilities offered by digital technologies. The current challenge is to integrate the best of both models, enhancing mathematical learning with methodologies that contemplate both conceptual solidity and didactic innovation (CAVALCANTE; SILVA, 2020).

On the other hand, technological methods have introduced a new dynamic to the teaching of mathematics. With the advent of computers, tablets, and smartphones, educators now have access to a wide range of resources that can be used to make teaching more interactive and engaging. Educational software and mathematical applications allow students to explore concepts in a visual and practical way, through simulations and animations that illustrate mathematical phenomena in an intuitive way (Table 1).

Table 1

Traditional and technological methods in the teaching of mathematics

Aspect	Traditional Methods	Technological Methods
Approach	Expository, based on textbooks and manual calculations.	Interactive, based on software, applications and online platforms.
Role of the Teacher	Central, acts as the main source of knowledge and advisor.	Facilitator, guides the use of technological tools and autonomous learning.
Student Engagement	It can be passive, depending on the methodology applied.	Usually more active, with the use of interactive and visual resources.
Feedback	Retarded, usually through correction of tests and exercises.	Immediate, with automatic correction on digital platforms.
Access to Content	Uniform, based on the curriculum and the pace of the class.	Personalized, allowing adaptation to the student's pace and level of knowledge.

Skill Development	Focus on memorization, repetition and manual problem solving.	Focus on concept visualization, simulations and assisted resolution.
Teaching Resources	Books, blackboards, notebooks, manual calculators.	Educational software, mobile apps, e-learning platforms.
Development of Critical Thinking	Developed through manual practice and complex problem solving without technological support.	Stimulated by the exploration of different approaches and visualizations, but may be limited by the overuse of technological assists.
Dependence on Technology	Low, focus on physical and manual resources.	High, depending on technological devices and internet access.
Accessibility and Inclusion	Widely accessible, but may not suit different learning styles.	Potentially limiting, as it relies on access to devices and connectivity, but supports different learning styles.
Real-World Preparation	It teaches fundamental skills such as manual calculation and logical reasoning.	Prepares students for the use of technology in practical contexts, but may not fully develop basic skills without balance
Teacher Training	Teachers are usually already trained and familiar with traditional methods.	It requires continuous training and adaptation for the effective use of new technologies.

Source: Prepared by the authors.

For example, interactive geometry applications allow students to manipulate geometric figures in real-time, observing how changes in dimensions affect properties such as area and perimeter. These features not only make learning more engaging but also make it easier to understand abstract concepts, which are often difficult to visualize through traditional methods. In addition, online teaching platforms offer a new form of autonomous learning, where students can access content and exercises that are customized according to their level of knowledge and learning pace. These platforms often utilize adaptive learning algorithms, which adjust the difficulty of exercises based on student performance, providing a more personalized learning environment. The instant feedback provided by these platforms is another key differentiator, as it allows students to identify and correct their mistakes immediately, reinforcing learning. This approach contrasts with traditional methods, where feedback is usually given after grading exams, often too late for students to effectively correct their knowledge gaps.

However, despite the advantages associated with the use of technology in mathematics teaching, there are also challenges and limitations that need to be considered. One of the main challenges is the issue of unequal access to technology. In many regions, especially in rural or lower-income areas, students may not have access to technological

devices or quality internet, which limits their ability to take advantage of available technological resources. This disparity in access can increase educational inequalities, creating a gap between those who have access to technology and those who do not.

In addition, there is a risk that over-reliance on technology could weaken basic skills such as mental calculation and problem-solving without the aid of digital tools. This is especially concerning in the context of mathematics, where the development of logical and critical reasoning skills is key. Another point to be considered is the training of teachers for the effective use of technologies in the teaching of mathematics. Many educators, trained in traditional methods, may feel unprepared or resistant to incorporating new technologies into their teaching practices.

Effective integration of technology requires not only familiarity with the available resources, but also an understanding of how to utilize them in a pedagogical way to enrich student learning. This requires investment in continuing education for teachers, as well as technical support in schools to ensure that technologies are used appropriately and efficiently. The comparative analysis between traditional and technological methods in the teaching of mathematics reveals that both have their merits and limitations. Traditional methods provide a solid foundation of knowledge, with an emphasis on repetition and memorization, which are important for the acquisition of fundamental skills. However, they may not be sufficiently engaging or adaptive to meet the individual needs of all students. In turn, technological methods offer a more interactive and personalized approach, which can make it easier to understand abstract concepts and keep students more engaged. However, its effectiveness depends on equitable access to technology and adequate teacher training.

In view of this analysis, the best approach seems to be the integration of both methods, using technologies as a complement to traditional teaching practices. This integration allows students to benefit from the advantages of both approaches, developing both fundamental skills and the ability to apply knowledge in practical and creative ways. For example, a math lesson might start with a traditional expository explanation, followed by the use of an app or software to reinforce the concept through interactive activities. This type of hybrid approach allows students to consolidate knowledge through repetition and memorization, while also exploring concepts in a more visual and practical way.

Additionally, integrating technologies into math education can facilitate the personalization of learning, allowing students to advance at their own pace and receive immediate feedback. This is particularly useful in heterogeneous classes, where students

may have different levels of knowledge and skills. Adaptive learning platforms can help identify the individual needs of each student and adjust activities accordingly, ensuring that everyone has the opportunity to reach their full potential.

3 CONCLUSION

The comparative analysis between traditional and technological methods in mathematics teaching highlights the importance of a balanced approach that combines the best of both worlds. While traditional methods continue to play a crucial role in forming a strong knowledge base, incorporating technologies can enrich learning and make mathematics more accessible and engaging for students. The challenge for educators and policymakers is to ensure that this integration is done in an equitable and effective way, providing all learners with the tools and opportunities they need to thrive in an increasingly digitized world.

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