LUMEN ET VIRTUS

The integration of digital technologies and educational robotics in school management: A comparative bibliographic study between the initial and final years and the education of young people and adults

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Kevin Cristian Paulino Freires[1]
Romário Nunes Pereira[2]
Maria de Jesus da Silva Vieira[3]
Ana Alice de Rezende Fonseca Theobald[4]
Wanderlei Batista Nunes[5]

ABSTRACT

The integration of digital technologies and educational robotics in school management involves the use of technological and robotic tools to improve educational and administrative processes, promoting a more interactive and efficient learning environment. The origin of this theme is related to the advancement of digital and robotic technologies in recent decades, and their growing application in the educational context as a means of innovating pedagogical and management practices. The incorporation of digital technologies and robotics in education has expanded globally, with initiatives aimed at preparing students for an increasingly technological job market. In Brazil, programs such as ProInfo and educational robotics projects in public and private schools have gained prominence, such as the assembly of simple robots to advanced programming, applied both in the early and late years of basic education, and in Youth and Adult Education (EJA). The research seeks to identify the differences and similarities in the integration of digital technologies and educational robotics between the initial and final years of basic education and EJA, evaluating the impacts on school management and the teaching-learning process. The rationale for this study lies in the need to understand how different age groups and levels of education are being impacted by emerging technologies, and how school management can adapt to maximize the benefits of these tools. The research is qualitative in nature, based on a literature review that includes academic articles, case studies, institutional reports, and other relevant sources to map the current state of technological integration in education. The results indicate that, while the initial years focus more on playful and interactive technologies to arouse the interest of students, the final years and EJA use more advanced and specific technologies, aiming to prepare students for academic and professional challenges, as well as the need for continuing education for teachers and curricular adaptations for better integration of these technologies. It is concluded that the integration of digital technologies and educational

[1] Doctor student in Educational Sciences at the Facultad Interamericana de Ciencias Sociales. Researcher at GEPREMAC/IFCE/CNPq. Professor-Trainer at SME Caucaia.
E-mail: freireskeven43@gmail.com
[2] Specialist in Natural Sciences and their Technologies and the World of Work from the Federal University of Piauí.
E-mail: romarionunes0765@gmail.com
[3] Master's student in Education at the European University of the Atlantic.
E-mail: mariavieira.ap@gmail.com
[4] Master's student in Emerging Technologies in Education at Must University.
E-mail: anaalicetheobald@gmail.com
[5] Master's student in Geography at the Federal University of Catalão (UFCAT) – GO.
E-mail: wandybn@gmail.com

robotics has significant advantages, such as greater student engagement and efficiency in school management. However, there are challenges such as the need for adequate infrastructure and teacher training. The research suggests public policies and targeted investments to overcome these barriers and enhance the benefits of educational technologies at all levels of education.

Keywords: Early and Final Years, Youth and Adult Education, School Management, Educational Robotics, Digital Technologies.

INTRODUCTION

The integration of digital technologies and educational robotics in school management represents one of the most significant evolutions in the contemporary educational field. Digital technologies, ranging from management software to online learning platforms, have revolutionized the way knowledge is transmitted and managed. In turn, educational robotics, which emerged at the end of the twentieth century with the aim of fostering practical learning and the development of technological skills, has become a crucial tool for the cognitive and social development of students. This work addresses the importance of these technologies in education, tracing a historical path from its origins to the current impact on educational institutions.

In the current context, the use of digital technologies and educational robotics not only facilitates the teaching-learning process, but also optimizes school management, making it more efficient and collaborative. The growing adoption of these technologies is directly related to changes in educational demands and the expectations of contemporary society, which values technological skills and the ability to solve complex problems. In addition, the use of these technologies varies significantly between the early and final years of elementary school and in youth and adult education (EJA), requiring approaches and solutions adapted to each context.

For example, the use of digital platforms to monitor academic performance, the introduction of educational robotics in curricular activities to promote creativity and critical thinking, and the implementation of communication tools that facilitate collaboration between teachers, students, and parents. Within the scope of EJA, digital technologies offer unique opportunities to overcome barriers to access and engagement, providing a more inclusive and motivating learning environment.

The objective of this research is to investigate how the integration of digital technologies and educational robotics can influence school management and student development, comparing their applications and results in the early and final years and in EJA. The methodological approach adopted is a bibliographic research of a qualitative nature, which allows an in-depth analysis of the different experiences and practices reported in the literature.

In the theoretical path, the main theories and studies on the impact of digital technologies and robotics in education will be addressed. This includes the analysis of specific skills developed through these tools, such as problem-solving, teamwork and innovation, as well as the efficiency of

digital technologies in improving school management and the challenges faced in implementing these technologies in EJA.

The structure of the work is organized as follows: initially, we will discuss the impact of educational robotics on the cognitive and social development of students, followed by the efficiency of digital technologies in school management. Then, we will explore the challenges and solutions in the implementation of these technologies in EJA, compare teaching methods with digital technologies between early and late years, and analyze teacher training for the use of these technologies. Subsequently, we will assess the impact of digital technologies on student engagement and motivation, discuss digital inequality and access to technologies, and examine the effects of educational robotics on job market readiness. Finally, we will address the curricular integration of digital technologies and robotics and the perceptions of students and teachers about the use of these technologies in the classroom. With this, the work is concluded with the final considerations, in which it brings a general synthesis of the research.

IMPACT OF EDUCATIONAL ROBOTICS ON STUDENTS' COGNITIVE AND SOCIAL DEVELOPMENT

Problem-solving and critical thinking skills refer to an individual's ability to analyze information, identify problems, develop viable solutions, and evaluate the results of those solutions. These skills are key to making informed and effective decisions, especially in complex and dynamic contexts. In the educational sphere, developing these skills means enabling students to face academic and everyday challenges in a more autonomous and creative way.

The origin of problem-solving and critical thinking skills dates back to the early days of philosophy, with thinkers such as Socrates, Plato, and Aristotle emphasizing the importance of questioning and critical reflection. In the modern era, these concepts have been improved and integrated into formal education by educators and psychologists such as John Dewey, who highlighted active learning and the importance of critical thinking in the educational process.

Historically, the development of these skills in the school curriculum has gone through several phases. In the twentieth century, with Dewey's influence, schools began to incorporate teaching methods that encouraged critical reflection and problem-solving. In Brazil, the New School movement also reinforced these ideas, advocating for a more practical and student-centered education. Recently, with the integration of educational technologies, such as robotics, these skills have been increasingly valued and cultivated through interactive and challenging activities.

In the context of educational robotics, problem-solving and critical thinking are essential skills. Robotics involves the construction and programming of robots, which requires students to be able to identify technical problems, formulate hypotheses, test solutions, and adjust strategies based

on the results obtained. This hands-on, investigative approach fosters deep and meaningful learning, preparing students to deal with complex and uncertain situations.

Practical examples of the development of these skills can be observed in robotics competitions, such as the Brazilian Robotics Olympiad (OBR). In these competitions, students must build and program robots to perform specific tasks, facing technical challenges that require critical analysis and real-time problem solving. Brazilian researchers, such as Valente (2019), have highlighted how these activities promote students' cognitive development, improving their critical thinking and problem-solving skills.

Collaboration and teamwork are processes in which individuals work together to achieve a common goal by sharing knowledge, skills, and efforts. In the educational context, these skills are essential for the social development of students, as they promote effective communication, empathy, negotiation, and cooperation.

Collaboration and teamwork have their roots in primitive human societies, where survival depended on the ability to work together. In the field of education, these concepts were formalized in the twentieth century by theorists such as Lev Vygotsky, who highlighted the importance of social interactions for cognitive development, and Kurt Lewin, who studied group dynamics and collaborative processes.

Historically, the emphasis on collaboration and teamwork in schools has grown with the appreciation of social and cooperative learning. In recent decades, collaborative teaching methods such as Project-Based Learning (PBL) and Cooperative Learning have become increasingly common. These methods encourage students to work together to solve complex problems, reflecting a shift towards a more holistic and student-centered education.

In the context of educational robotics, collaboration and teamwork are key. Robotics projects often require students to work in groups, dividing up tasks such as building, programming, and testing the robots. This process not only improves students' technical skills but also develops their soft competencies, preparing them to collaborate effectively in work environments and other social contexts.

A notable example is the SESI Robotics Program, which promotes the formation of teams of students to participate in robotics competitions. In these competitions, students must work together to design and build robots that perform specific tasks, encouraging cooperation, communication, and the division of responsibilities. Studies by Ramos (2020) show that these collaborative activities not only improve students' academic performance but also increase their ability to work as a team and resolve conflicts in a constructive manner.

The development of creativity and innovation refers to the ability to generate new ideas, approaches, and solutions to complex problems. Creativity is the ability to think in an original way

and find new and effective ways to accomplish tasks, while innovation is the practical application of these ideas to improve processes, products, or services.

Creativity and innovation have been studied since antiquity, with philosophers such as Plato and Aristotle discussing the nature of human creativity. In the twentieth century, psychologists such as J.P. Guilford and Howard Gardner explored creativity as a cognitive skill, while innovation theorists such as Joseph Schumpeter highlighted the importance of innovation for economic and social development.

Historically, the emphasis on developing creativity and innovation in education has increased, especially with the advent of the knowledge economy. In Brazil, educational initiatives such as the National Common Curriculum Base (BNCC) highlight the importance of promoting creativity and innovation as essential skills for the 21st century. Emerging technologies, such as educational robotics, have proven effective in fostering these skills among students.

Educational robotics offers an environment conducive to the development of creativity and innovation. When working with robotics, students are encouraged to experiment, make mistakes, and try again, which is fundamental to the creative process. Robot programming allows students to explore new ways to solve problems by encouraging innovation through the practical application of original ideas.

A concrete example is the use of LEGO Mindstorms robotics kits in Brazilian schools, which allows students to create and program their own robots. These activities foster a creative learning environment where students can experiment with different solutions and see the immediate results of their innovations. Research by Silva and Souza (2021) points out that students who participate in educational robotics activities show a significant increase in the ability to generate innovative ideas and apply them in practical contexts.

Improving student engagement and motivation refers to the process of increasing student interest, willingness, and participation in academic and school activities. Engagement is associated with the active involvement of students with content and activities, while motivation is the internal force that drives the desire to learn and achieve goals.

The origin of the concern with student engagement and motivation can be traced back to the principles of educational psychology and pedagogy, with influences from theorists such as Jean Piaget and Lev Vygotsky. In the twentieth century, researchers such as Abraham Maslow and Frederick Herzberg contributed theories about human motivation, emphasizing the importance of basic needs and incentives for motivated behavior.

Historically, the focus on student motivation and engagement has undergone significant changes. In traditional methods, the focus was primarily on the transmission of knowledge, with little regard for the emotional and motivational needs of students. From the 1970s onwards, education

began to incorporate practices that consider engagement and motivation, with the introduction of active and project-based methodologies. The growing use of educational technologies, such as robotics, has enhanced these practices by providing more engaging and dynamic learning experiences.

In the context of educational robotics, improved engagement and motivation is one of the most notable benefits. The hands-on, interactive activities associated with robotics capture students' interest and stimulate their curiosity. Building and programming robots are often seen as challenging and rewarding tasks, which increases students' motivation to actively participate in the learning process. This hands-on approach helps turn learning into a more fun and meaningful experience.

For example, the use of the FIRST LEGO League program, which organizes robotics competitions for students around the world. Participants in these competitions often report a significant increase in their motivation and academic engagement, attributed to the competitive and collaborative aspect of the activities. Studies such as that of Oliveira and Lima (2021) indicate that participation in robotics competitions not only improves student motivation but also contributes to an overall increase in academic performance and attitudes towards learning.

Educational robotics impact assessment refers to the process of measuring and analyzing the effects and benefits of implementing robotics activities in the school environment. This includes assessing changes in students' cognitive, social, and academic skills, as well as the overall impact on teaching quality and school management.

Impact assessment in education has its roots in the practices of pedagogical and psychological assessment, developed throughout the twentieth century. Theorists such as Robert Stake and Michael Scriven have been pioneers in formulating assessment methods that help to understand the effectiveness and effectiveness of educational practices.

The development of impact assessment in educational robotics goes hand in hand with the increasing integration of robotics in schools. Initially, the evaluations were more informal and based on qualitative observations. Over time, more systematic and quantitative methods were incorporated, including academic performance data analyses and feedback questionnaires. Empirical research on the impact of educational robotics has been expanding, with recent studies showing positive effects on student skills and classroom dynamics.

In the context of educational robotics, impact assessment is crucial to understanding how these activities affect student learning and development. This assessment can involve academic performance metrics, feedback from students and teachers, and qualitative analyses of how robotics influences student engagement and motivation. The results of these assessments provide valuable information to improve educational practices and justify investment in robotics technologies.

An example is the study conducted by Costa and Almeida (2022), which evaluated the impact of educational robotics programs in public schools in Brazil. The results indicated significant improvements in students' problem-solving and teamwork skills, as well as an overall increase in interest in math and science. This study exemplifies how impact assessment can provide concrete evidence of the benefits of educational robotics and help inform future implementations and pedagogical practices.

EFFICIENCY OF DIGITAL TECHNOLOGIES IN IMPROVING SCHOOL MANAGEMENT

Digital tools for school administration are technological platforms and applications designed to assist in the management and organization of administrative and academic activities of an educational institution. These tools can include data management software, communication platforms, and integration systems that facilitate the administration of academic records, attendance control, financial management, and communication between the school and the community.

The origin of digital tools for school administration is linked to the advancement of information and communication technology (ICT) and the growing use of computers and software in the last decades of the twentieth century. The transition from manual administrative processes to digital solutions began to intensify with the popularization of computers and the internet, enabling the creation of more effective systems for school management.

The historical journey of digital tools for school administration began with basic academic records management systems, which evolved into more complex and integrated platforms. In the 1980s and 1990s, early versions of school management software were limited to basic functions such as record-keeping and reporting. With technological advancement, especially in the 2000s, more sophisticated systems emerged that integrated multiple functions and allowed for more comprehensive and efficient management. Today, these tools are essential for the administration of educational institutions and offer functionalities ranging from communication with parents and students to the analysis of academic data.

In the current context, the use of digital tools for school administration is crucial for the efficiency of operations in educational institutions. These tools allow for a more organized and integrated management of school activities, facilitating the automation of processes and efficient communication between all those involved. The digitalization of administrative processes contributes to the reduction of errors, optimizes the use of resources, and improves the overall quality of school administration.

An example of a widely used digital tool is the School Management System (SGE), which offers resources for enrollment management, attendance control, report card generation, and communication with parents. Platforms such as Google Classroom and Microsoft Teams have also

been adopted to support administrative and pedagogical activities, integrating features that allow the monitoring of student progress and direct communication between teachers, students, and parents. According to the study by Costa and Almeida (2023), these tools have demonstrated a positive impact on the administrative efficiency of schools, contributing to a more effective and integrated management.

Academic performance monitoring and analysis refers to the process of collecting, analyzing, and interpreting data on student performance in educational activities. This process involves using tools and techniques to assess students' progress, identify areas of difficulty, and provide feedback to improve the teaching-learning process.

Historically, the monitoring and analysis of academic performance emerged as part of the evolution of educational evaluation practices. Since the beginning of the twentieth century, with the introduction of standardized tests and psychometric assessments, schools began to collect data on student performance. The arrival of digital technologies in recent decades has significantly expanded the possibilities of monitoring and analysis, offering more sophisticated and integrated tools.

The historical path of academic monitoring began with traditional assessments, such as tests and exams, which were held periodically to measure student progress. With the advent of digital technologies, especially in the last two decades, learning management systems (LMS) and educational data analytics platforms have emerged. These tools allow for a more detailed and continuous analysis of student performance, enabling a more personalized and effective approach to educational intervention.

In the context of digital technologies, the monitoring and analysis of academic performance has gained a new dimension with the implementation of school management platforms. These platforms allow for real-time tracking of student progress, making it easier to identify trends and patterns in academic performance. Data analytics can help educators fine-tune their pedagogical practices and provide additional support to students who are struggling with content.

A practical example is the use of platforms such as Google Classroom and Moodle, which offer features for continuous monitoring of student performance. These platforms allow teachers to view student progress in real-time, access detailed reports, and identify areas that need attention. Studies such as that of Silva and Barbosa (2023) show that the use of these tools contributes to a more efficient management of academic performance and improves the ability of educators to provide targeted interventions.

Communication and collaboration between teachers, students, and parents involves exchanging information and working together to support the educational process. This includes exchanging feedback, engaging parents in school activities, and creating collaborative strategies to promote students' academic success.

The origin of communication and collaboration in education dates back to the traditional practices of interaction between school and family, which were predominantly face-to-face and based on meetings and correspondence. With digitalization, communication began to include electronic tools, such as emails and messaging platforms, which facilitated faster and more efficient communication.

Historically, communication between teachers, students, and parents was limited to face-to-face meetings and progress reports. The introduction of digital technologies in the late twentieth and early twenty-first centuries revolutionized this interaction, allowing the use of online platforms and apps for communication and collaboration. This has expanded the ability of parents and students to interact and be involved in the educational process, offering more accessible and effective channels.

In the current scenario, technology plays a crucial role in facilitating communication and collaboration between all parties involved in education. Digital tools, such as school management platforms and communication apps, allow for the instant exchange of information and the tracking of student progress. These technologies promote greater transparency and collaboration, which can result in a more cohesive and integrated educational experience.

One example of success is the use of platforms such as Schoology and ClassDojo, which allow for effective communication between teachers, students, and parents. These platforms provide real-time updates on student performance and allow parents to actively engage in their child's education. According to a study by Almeida and Santos (2022), the use of these tools significantly improves communication and collaboration, resulting in greater parental participation and better academic performance of students.

Reducing the administrative and bureaucratic burden refers to reducing administrative tasks and bureaucratic processes that consume time and resources in educational institutions. This is usually achieved through the automation of processes and the implementation of technologies that simplify school management.

The need to reduce the administrative burden arose with the increase in administrative responsibilities in schools, which often overburdened educators and administrators. The implementation of digital technologies and school management systems in recent decades has aimed to alleviate this burden by providing solutions that automate and streamline administrative processes.

Historically, school administration involved a great deal of manual labor and paperwork. With the advancement of technology, especially from the 2000s onwards, computerized systems emerged that began to replace manual tasks with automated processes. This included the use of school management software and automation platforms for academic records, scheduling, and communication, significantly reducing the time spent on bureaucratic tasks.

In the current context, reducing the administrative burden is crucial to improve the operational efficiency of schools and allow educators to focus more on teaching and supporting students. Digital technologies offer solutions that automate tasks such as recording grades, managing attendance, and generating reports, freeing up time and resources for more productive pedagogical activities.

Platforms such as the School Management System (SGE) and Microsoft Teams have been shown to be effective in reducing the administrative burden. These tools allow for the automation of processes such as generating report cards and managing academic records, resulting in a more agile and less bureaucratic school administration. Studies, such as that of Carvalho and Silva (2023), show that the adoption of these technologies can reduce the time spent on administrative tasks by up to 40%, allowing teachers to focus more on their pedagogical activities.

The implementation of integrated school management systems refers to the adoption of technological platforms that unify various aspects of school administration, such as academic records, communication, and resource management. These systems aim to offer a comprehensive and coordinated view of school operations.

The origin of integrated school management systems can be traced back to the development of information and communication technologies in the late twentieth century.

The concept of integrated school management systems evolved from fragmented systems that initially managed only specific aspects of school administration. With technological advancement, integrated solutions have emerged that combine features such as enrollment management, attendance control, and communication with parents and students. These systems became widely adopted in the early twenty-first century, offering a more efficient and centralized approach to school management.

In today's educational landscape, the implementation of integrated school management systems is essential to improve administrative efficiency and the quality of school service. These systems allow for a unified view of all school operations, facilitating informed decision-making and coordination between different areas of the institution. The integration of data and processes improves communication and collaboration, as well as providing more effective management of school resources.

Systems such as TOTVS Educação and Plataforma Lattes are examples of integrated solutions that have been adopted by educational institutions to manage various aspects of school administration. According to a study by Oliveira and Freitas (2023), the implementation of these systems has integrated previously dispersed functions, improving administrative efficiency and communication within institutions, resulting in a more organized and productive school environment.

CHALLENGES AND SOLUTIONS IN THE IMPLEMENTATION OF DIGITAL TECHNOLOGIES AND ROBOTICS IN YOUTH AND ADULT EDUCATION

Technological and infrastructure barriers refer to the obstacles that hinder the adoption and effective use of digital technologies and robotics in educational settings. These challenges can include a lack of proper equipment, unstable internet connections, and the absence of appropriate technical support. These barriers compromise the ability of institutions to implement and use modern technologies that could enrich the teaching-learning process.

The origin of these barriers is often linked to the uneven development of technological infrastructures and the lack of investment in educational technologies. In many contexts, especially in less favored regions, the lack of financial resources and public policies aimed at technological modernization contributes to these difficulties. Inequality in access to technologies is a reflection of economic and social disparities that affect various areas of society.

Historically, the development of educational technologies has advanced faster in areas with greater investment in infrastructure and research. In recent decades, inequalities have become more evident with the increase in digitalization and the integration of technologies in schools. Since the early 2000s, digital inclusion programs and government initiatives have attempted to mitigate these barriers, but significant challenges remain, especially in rural areas and in low-income communities.

In the current context, overcoming these barriers is essential to ensure that all students have equitable access to educational technologies. Institutions need adequate technological infrastructure to effectively implement digital tools and robotics, and this includes investments in hardware, software, and connectivity. The absence of such resources can create a digital divide, limiting learning opportunities and the quality of education offered.

In Brazil, projects such as the Digital Inclusion in Schools Program (PIDE) have been developed to address these barriers, providing equipment and training to schools in underserved areas. However, many challenges remain. A notable example is the study by Souza and Lima (2022), which highlights how the lack of adequate infrastructure still limits the effective implementation of technologies in public schools in the interior, affecting the quality of teaching and the ability of students to benefit from new digital tools.

Teacher training and continuing education refer to the training and updating processes that educators receive to adapt to new technologies and teaching methodologies. These programs aim to enhance teachers' competencies to integrate digital technologies and robotics into their pedagogical practices, ensuring that they can use these tools effectively and productively.

The need for training and continuing education arose with rapid technological advancement and the growing integration of digital tools in education. As new technologies emerge, educators need specialized training to stay current and able to use these tools to improve teaching. The origin of this

demand lies in the constant evolution of the educational environment and the new demands placed on teachers.

Historically, teacher education has always focused on traditional methodologies, with little emphasis on emerging technologies. With the advancement of technology and the introduction of new tools in the school environment, continuing education has become a priority. Since the 2010s, several continuing education programs and courses have been developed to train teachers in digital technologies, with the aim of improving pedagogical practice and the integration of new tools in teaching.

In today's educational landscape, continuous teacher training is crucial to ensure the effective integration of digital technologies and robotics. Teachers need to be well prepared to use these tools in a way that maximizes the benefits for students. Without proper training, the adoption of new technologies can be ineffective and even harmful, resulting in a limited impact on improving the quality of education.

Programs such as "Digital Education" promoted by the Ministry of Education (MEC) have been implemented to provide continuing education to teachers in digital technologies. In a recent study, Almeida and Silva (2023) highlight that schools that invested in continuing education programs for their teachers were able to integrate technologies more effectively into their pedagogical practices, resulting in an improvement in student engagement and the quality of teaching.

Adapting curricula to include digital technologies refers to reviewing and updating teaching content and methodologies to integrate the use of modern technologies into the educational process. This involves incorporating digital tools, online platforms, and innovative methodologies into the planning and execution of classes, aiming to improve learning and prepare students for the digital world.

The origin of the need for curricular adaptation is linked to the evolution of digital technologies and their growing impact on society. With the advent of the internet and digital tools, it became evident that educational curricula needed to be updated to reflect the new competencies and skills needed in the twenty-first century. The integration of digital technologies into curricula aims to ensure that students develop skills relevant to today's job market.

The historical path of curricular adaptation to include digital technologies began in a more pronounced way in the 2000s, with the growing adoption of computers and the internet in schools. Initially, integration was limited and often focused solely on the inclusion of technologies as part of extracurricular activities. Over time, there has been a growing movement to integrate technologies more deeply into the curriculum, reflecting the importance of these tools for modern education.

Adapting curricula to include digital technologies is key to preparing students for an increasingly digital world. This adaptation allows students to develop technological skills from an early age, which is crucial for their future insertion in the job market. In addition, the integration of technologies into the curriculum can make the teaching-learning process more dynamic and engaging, promoting a more relevant and up-to-date educational environment.

In Brazil, the National Common Curriculum Base (BNCC) already includes guidelines for the integration of digital technologies in education. The implementation of programs such as "Computing in Education" has been an attempt to adapt curricula to reflect the importance of digital skills. According to the study by Costa and Lima (2023), schools that adopted these guidelines and adjusted their curricula to include digital activities saw an increase in student interest and an improvement in the development of technological skills.

Adult learner engagement and motivation refers to the level of interest and involvement that adults demonstrate in their educational activities. This concept encompasses the willingness of adult learners to actively participate in learning processes and the enthusiasm with which they face educational challenges, influenced by factors such as content relevance, teaching methods and support received.

The concept of engagement and motivation of adult learners originates from the need to understand how different age groups approach the educational process. Motivation for adult learning can be distinct from that seen in younger students, often being driven by specific professional or personal goals. Educational psychology and adult learning theories provide the foundation for understanding these motivational factors.

Historically, adult education has been seen mainly from the perspective of professional retraining and continuing education. Over time, research on engagement and motivation in adult contexts has evolved to consider the specific needs and interests of this group. In recent years, with the growth of online education and flexible learning modalities, understanding how to engage and motivate adult learners has become a key focus for improving the effectiveness of these programs.

In the context of youth and adult education, engagement and motivation are crucial to the success of educational programs. Adults pursuing education often have professional and personal commitments that compete for their time and attention, making it essential to create learning experiences that are relevant and flexible. The integration of digital technologies and innovative methodologies can play an important role in increasing the motivation and engagement of these students.

Distance education programs, such as those offered by platforms such as Coursera and SENAI, have been shown to be successful in engaging adult learners by offering courses that can be adjusted to their needs and schedules. According to a study by Ferreira and Santos (2024), the use of

active methodologies and the provision of relevant and applicable content to students' professional and personal lives are key factors to increase engagement and motivation in adult education programs.

Public policies and funding for educational technology involve the strategies and financial resources directed by the government and other entities to support the integration and development of technologies in education. These policies may include the creation of incentive programs, the allocation of resources for the acquisition of technologies, and the formulation of guidelines for their effective implementation in schools and educational institutions.

The origin of these policies and funding for educational technology is linked to the growing recognition of the importance of technologies in modern education. With the evolution of the digital society and the need to prepare students for the technological job market, governments and international organizations have begun to develop and fund initiatives to promote digital inclusion and educational innovation.

Historically, funding and public policies for educational technology began to gain prominence at the end of the twentieth century, with the advent of the internet and digital technologies. In the 2000s, several countries launched programs to integrate technology in schools, such as the "One Computer per Student Program" (UCA) in Brazil. The following decade saw an expansion of these initiatives with increased investment in technological infrastructure and the introduction of policies to modernize educational curricula.

In Brazil, public policies such as the National Education Plan (PNE) and the Digital Education Program have been fundamental for the financing and implementation of technologies in schools. However, the effectiveness of these policies is often compromised by challenges such as regional inequality and lack of continuity in investments. The successful integration of digital technologies and robotics requires a coordinated approach that includes financial support, infrastructure development, and training of education professionals.

The National Fund for the Development of Education (FNDE) has promoted initiatives to finance educational technology in Brazil, such as the acquisition of computers and digital resources for public schools. An example is the "Basic Education Innovation Program" (PIEB), which provides financial support for the implementation of digital technologies and innovative projects in schools. Studies such as that of Oliveira and Martins (2024) highlight that, despite advances, the effectiveness of these policies may be limited by uneven implementation and the need for greater continuous support for educational institutions.

COMPARISON OF TEACHING METHODS WITH DIGITAL TECHNOLOGIES BETWEEN INITIAL AND FINAL YEARS

Age-appropriate pedagogical approaches refer to teaching methodologies that are adjusted to meet the specific cognitive and emotional needs of students at different stages of development. This involves choosing didactic strategies, resources, and teaching practices that are appropriate to the students' level of maturity and learning ability, ensuring that the content is accessible and relevant.

The concept of adapted pedagogical approaches has its roots in developmental psychology and educational theory, which suggest that learning is most effective when teaching is aligned with students' cognitive and affective capacities. Figures such as Jean Piaget and Lev Vygotsky contributed to the understanding of how children learn at different ages and the importance of adjusting pedagogical strategies for these stages.

Historically, the adaptation of teaching methodologies according to the age group of students began to be formalized with the theories of cognitive development in the early twentieth century. Piaget's ideas about the stages of cognitive development and constructivist approaches influenced pedagogical practice, leading to the creation of teaching methods that consider the intellectual and emotional maturity of students, such as game-based learning for the early years and complex problem-solving for the later years.

In the current context, tailored pedagogical approaches are key to ensuring that learners of different ages receive effective and stimulating teaching. In the early years, for example, the emphasis may be on practical and playful activities that develop basic skills, while in the later years, methodologies may focus on more advanced analytical and critical skills. This adaptation helps to maintain student engagement and promote more meaningful and lasting learning.

In Brazil, the National Common Curriculum Base (BNCC) is an example of how pedagogical approaches are adapted to different stages of basic education. For the initial years, the BNCC suggests practical and interactive activities that favor the development of reading and writing skills, while for the final years, the focus is on more complex skills, such as problem solving and critical analysis. A study by Ribeiro and Costa (2023) showed that the adaptation of teaching methods contributes significantly to increasing students' motivation and performance at different stages of education.

Learning outcomes and academic performance refer to the evidence and assessments that demonstrate the effectiveness of teaching methodologies and the level of acquisition of knowledge and skills by students. These results are often measured through tests, continuous assessments, and other assessment methods that reflect students' progress toward established educational goals.

The origin of the concept of learning outcomes and academic performance lies in educational evaluation, which seeks to measure and evaluate the impact of pedagogical practices on student

learning. Theories of educational assessment have evolved over time, from traditional methods based on standardized tests to more holistic approaches that consider the development of skills and competencies.

The historical journey of learning outcomes assessment began with simple quantitative methods such as tests and exams and has evolved to include more comprehensive assessments that consider practical skills and critical competencies. In the 1990s, approaches such as formative assessment emerged, which focuses on continuous feedback to improve learning throughout the educational process, and, more recently, the use of digital technologies has allowed for more dynamic and interactive assessments.

Currently, learning outcomes and academic performance are analyzed based on multiple criteria, including the effectiveness of teaching methodologies and the impact of digital technologies on education. Digital tools and educational platforms provide new ways to assess and track student progress, allowing for a more detailed and individualized analysis of academic performance.

An example of how digital technologies influence learning outcomes is the use of adaptive teaching platforms, such as Khan Academy and Google Classroom, which offer real-time feedback and adjust content based on student performance. A study conducted by Lima and Fernandes (2023) showed that the use of these tools significantly improves students' academic performance by providing a more accurate and personalized assessment of educational progress.

The development of technological skills from an early age refers to the introduction and teaching of skills related to digital technologies from the early years of schooling. This includes familiarization with digital tools, the use of educational software, and the development of programming and computational thinking skills.

The origin of the focus on developing technological skills from an early age is linked to the growing importance of technology in modern society and the need to prepare students for a digital future. The idea is that early exposure to digital technologies provides a solid foundation for future technological competence and promotes the integration of these skills into the educational curriculum from childhood.

The concept of developing technological skills from an early age began to gain strength with the popularization of personal computers and the internet in the 1990s. Early initiatives included the introduction of computer classes in schools. With the advancement of digital technologies, the focus has expanded to include programming skills and critical use of digital tools as an essential part of the school curriculum.

In the current context, the inclusion of technological skills in the school curriculum is seen as crucial to prepare students for life and the job market in the twenty-first century. The BNCC, for example, incorporates digital competencies as part of the learning objectives, reflecting the

importance of equipping students with the skills they need to navigate an increasingly technological world.

Initiatives such as "Código Brasil", a program to encourage education in programming and digital technologies from childhood, exemplify the development of technological skills from an early age. In addition, schools that implement STEAM (Science, Technology, Engineering, Art, and Math) curricula often include hands-on programming and robotics activities from the earliest years. Studies such as that of Almeida and Silva (2024) show that the early introduction of these skills improves digital fluency and students' interest in technological careers.

The integration of interactive activities and educational games involves the use of methods and tools that encourage active student participation and learning through games and hands-on activities. These approaches seek to make the teaching process more engaging and motivating, using interactivity and play as pedagogical strategies to facilitate learning.

The concept of using games and interactive activities in teaching has roots in the theory of playful learning, which dates back to scholars such as Friedrich Fröbel and Jean Piaget. Fröbel, for example, believed that play was essential for children's cognitive development. With the advancement of digital technologies, this approach has evolved to include electronic games and interactive platforms as teaching tools.

Historically, the use of educational games began with toys and board games in early childhood education. From the 2000s onwards, with the growth of digital technology, electronic educational games and interactive platforms began to be integrated into the school curriculum. Pedagogical practices have evolved to incorporate these technologies, reflecting a greater emphasis on gamification and methodologies that use digital interaction to promote learning.

Currently, the integration of interactive activities and educational games is widely recognized as an effective approach to increase student engagement and motivation. Tools such as educational digital games and interactive learning platforms offer immersive and adaptive learning experiences, which can be adjusted for different skill levels and student interests.

One notable example is the use of "Kahoot!" in classrooms, a platform that allows you to create interactive quizzes and trivia games that engage students and provide immediate feedback. Another example is "Scratch", a visual programming language developed by MIT, which is widely used in schools to teach programming concepts and computational thinking through playful activities. Studies such as that of Oliveira and Lima (2023) show that the use of these tools can significantly improve student engagement and performance.

The impact and challenge assessment refers to the process of analysing the effects of digital technologies and robotics on teaching and learning, as well as the obstacles faced during the

implementation of these technologies. This assessment seeks to measure the real benefits of digital tools, identify problems and develop strategies to overcome the associated challenges.

The origin of the assessment of impacts and challenges lies in the need to understand the effectiveness and feasibility of digital technologies in education. With the increasing adoption of these technologies has arisen the need to evaluate not only the positive outcomes but also the challenges and difficulties that arise during their implementation and use.

The assessment of impacts and challenges began to be more formalized with the growing adoption of digital technologies in education in the 2000s. Initially, studies focused mainly on the benefits, but over time, research also began to consider challenges, such as resistance to change, inequality of access, and the need for adequate training for teachers.

In the current context, the assessment of impacts and challenges is crucial to ensure that digital technologies and robotics are effectively and sustainably integrated into educational practices. Continuous studies help to identify effective practices, in addition to offering solutions to the problems found, promoting a more successful and equitable implementation of these technologies.

An example of impact evaluation is the study carried out by Santos and Rocha (2023), which analyzed the effectiveness of e-learning platforms in different school contexts and identified challenges such as the lack of adequate infrastructure and the need for teacher training. Another example is the OECD report on the impact of digital technologies on education, which highlights both the advances and challenges faced by schools when incorporating new technologies into the curriculum. These studies help guide policies and practices to improve integration and maximize the benefits of digital technologies in education.

TEACHER TRAINING FOR THE USE OF DIGITAL TECHNOLOGIES AND EDUCATIONAL ROBOTICS

The development and application of digital teaching materials involves the creation and use of educational resources that are made available in digital format to support teaching and learning. These materials can include videos, animations, interactive simulations, e-books, among others, which aim to enrich the educational experience and make the content more accessible and engaging for students.

The origin of digital teaching materials is linked to the advancement of information and communication technologies and the growing integration of these technologies in education. Since the early 2000s, with the growth of the internet and digital devices, there has been a significant increase in the creation of digital resources for education, motivated by the need to innovate and modernize pedagogical practices.

Historically, digital learning materials have evolved from simple text-based resources and static images to include interactive and adaptive multimedia resources. In the early years, digital materials were predominantly static resources, such as PDFs and slide presentations. With the advancement of technologies, there has been a transition to more interactive and dynamic features, such as simulations and educational games, which provide a richer and more engaging learning experience.

In the current scenario, the use of digital teaching materials is considered an essential practice to modernize teaching and meet the needs of digital students. These tools allow for more personalized and flexible learning, facilitate collaboration and access to content, and can be adjusted for different learning styles and paces. Effectively integrating these materials into the curriculum can help improve students' engagement and knowledge retention.

One example is the use of platforms such as "Khan Academy" and "Coursera", which offer a wide range of digital educational resources, including videos and interactive exercises. Studies, such as that of Pereira and Silva (2023), show that the use of these materials can increase student engagement and improve learning outcomes, especially when combined with effective pedagogical practices.

The integration of artificial intelligence (AI)-based learning tools refers to the incorporation of AI technologies into the educational environment to personalize and improve the teaching and learning process. These tools use AI algorithms to tailor content and activities to students' individual needs, offering more personalized and efficient learning.

The origin of AI-based learning tools lies in AI's growing ability to analyze large volumes of data and make predictions based on detected patterns. Since the early 2010s, the application of AI in education has begun to gain attention, as AI algorithms and models have become more sophisticated and accessible, allowing for the creation of more advanced educational tools.

Historically, the application of AI in education began with the development of intelligent tutoring systems and adaptive platforms. In the 2010s, the advancement of AI allowed the creation of more advanced tools, such as educational chatbots and content recommendation systems. With the continued advancement of technology, AI-powered learning tools are becoming more integrated and effective, offering a wider range of functionality and personalized support for students.

Currently, AI-based learning tools are gaining prominence for their ability to offer personalized support and tailor teaching to the individual needs of students. They can help identify areas of difficulty, offer real-time feedback, and adjust content to meet each student's pace and learning style, making the educational process more efficient and tailored to individual needs.

One example is the use of platforms such as "Duolingo", which uses AI to personalize language lessons based on the user's performance. Another example is "DreamBox," an adaptive

math platform that adjusts exercises and content based on student progress. Studies such as that of Costa and Almeida (2023) demonstrate that the use of these tools can improve students' academic performance and motivation by offering a more personalized and effective learning experience.

Examples of implementing digital technologies and robotics in education refer to specific, practical cases of how these technologies are integrated into educational practices to improve teaching and learning. These examples demonstrate how technologies can be applied in different contexts and levels of education to achieve educational goals.

The origin of the examples of implementation of digital technologies and robotics lies in the growing adoption of these technologies in schools and educational institutions around the world. With the advancement of technologies and the increase in interest in educational innovation, several examples of how technologies can be applied to enrich the educational environment and improve learning outcomes have emerged.

Historically, the implementation of digital technologies and robotics in education began with pilot projects and experimental initiatives, often funded by government agencies and non-profit organizations. Over time, these initiatives have expanded and become more common, as schools and educational institutions have begun to recognize the benefits and feasibility of these technologies.

In the current context, the examples of implementing digital technologies and robotics provide valuable insights into how these tools can be used effectively to improve teaching and learning. They help demonstrate best practices, identify challenges, and show the impact of technologies on education. These examples also provide models that can be replicated and adapted for different educational contexts.

An example is the "Robotics in Schools" project, which introduced robotics kits in elementary schools to teach programming and engineering concepts. Another example is the use of "Augmented Reality" to teach science and mathematics, such as the "AR Labs" project, which allows students to explore complex concepts through immersive experiences. Studies such as that of Santos and Pereira (2024) show that these implementation examples have a positive impact on student engagement and learning, offering practical models for the integration of digital technologies and robotics in education.

The challenges and future perspectives in the use of digital technologies and robotics refer to the difficulties encountered in the implementation and use of these technologies in education and the future trends and possibilities that may impact the way they are integrated and used.

The challenges in utilizing digital technologies and robotics arise from the complexity and rapid evolution of technologies, as well as issues related to infrastructure, training, and resistance to change. The future prospects are based on emerging research and trends in the field of educational technology and robotics.

Historically, challenges in the use of digital technologies and robotics have included issues such as the lack of technological infrastructure, the need for teacher training, and resistance to the adoption of new technologies (Freires et al., 2024). As technology evolves and becomes more accessible, new challenges and opportunities arise, requiring a continuous and adaptive approach to the integration of these technologies into education.

In the current scenario, the challenges include the need for constant updating of technologies, the adequate training of educators, and the overcoming of financial and logistical barriers to the implementation of digital technologies and robotics in schools. Future prospects include the advancement of artificial intelligence, the expansion of augmented and virtual reality, and the increased personalization and adaptability of educational resources.

An example of a challenge is the difficulty of accessing digital technologies in rural areas and disadvantaged communities, which can limit equity in access to educational tools. Regarding future prospects, the growing use of technologies such as "Quantum Computing" and "Advanced Artificial Intelligence" promises to further transform the educational landscape, offering new opportunities and challenges for education. Studies such as that of Ferreira and Martins (2024) highlight the importance of addressing these challenges and exploring the new possibilities to ensure that the integration of digital technologies and robotics in education continues to evolve and benefit students effectively.

Initial and continuing teacher education for the use of digital technologies and educational robotics refers to the education and training that educators receive to effectively integrate these technologies into their teaching practices. Initial training takes place during teacher preparation at university or in initial training courses, while continuing education is a career-long learning process that aims to update and expand teachers' skills as technologies evolve.

The need for training in the use of digital technologies and robotics arose with the growing integration of these tools in the educational environment. Since the late 2000s, the expansion of digital technologies and the inclusion of robotics in classrooms have created a demand for specialized training to ensure that teachers can utilize these technologies effectively. The origin of this need is directly linked to the technological revolution and the recognition that the training of educators must follow the advancement of available tools.

Historically, teacher training in the use of digital technologies and robotics began with isolated initiatives and pilot programs. In the early years, training was limited and focused on basic technical aspects. Over time, the approach has evolved to include specific pedagogical methodologies for the use of these technologies, reflecting the growing importance of digital technologies in education. Today, training is more structured and integrated, with programs that combine technical and pedagogical aspects for a more effective implementation.

In the current context, initial and continuing teacher training is essential to maximize the impact of digital technologies and robotics in education. The ability of educators to incorporate these tools into pedagogical practices can directly influence teaching effectiveness and student engagement. Therefore, it is crucial that training programs address both the technical aspect of technologies and pedagogical strategies to use them in a meaningful way.

An example of initial training is the "Technologies and Education" course offered by several universities, which prepares future teachers to integrate digital technologies into teaching. For continuing education, the "Training Program for Educators in Educational Robotics" promoted by institutions such as SENAI offers regular training for teachers, covering everything from basic programming to the development of robotic projects in the classroom. Studies such as that of Souza and Lima (2023) demonstrate that continuous training is crucial for teachers to feel confident and prepared to use advanced technologies, thus improving the impact of these tools in education.

FINAL CONSIDERATIONS

The integration of digital technologies and educational robotics in school management reveals itself as a driver of transformation in contemporary education, offering significant innovations both in the teaching-learning process and in school administration. This study showed that such technologies facilitate educational management and play a crucial role in the cognitive and social development of students, promoting essential skills for the 21st century, such as critical thinking, problem-solving, and collaboration.

The positive impacts of digital technologies and robotics are visible on several fronts. In the early years, these tools create a more interactive and engaging learning environment, which is fundamental for the formation of children's first academic and social skills. In the final years, the complexity of technological tools aligns with the growing demands of curricula, preparing students for more advanced academic challenges and the job market. In youth and adult education (EJA), digital technologies are particularly valuable, helping to overcome barriers to access and engagement, offering a second educational opportunity in a flexible and inclusive way.

Despite the benefits, the effective implementation of these technologies faces significant challenges. Issues such as inequality of access, the need for adequate infrastructure, and the continuous training of teachers are obstacles that need to be overcome to ensure full and effective integration. In addition, adapting curricula to include these technologies in a meaningful way and continuously evaluating outcomes are crucial to maximizing educational benefits.

This study highlights the importance of public policies and continuous investments in the technological infrastructure of schools, as well as in the training of teachers and the creation of support programs that encourage the adoption of new technologies. Collaboration between educators,

school administrators, parents, and the community is key to creating an educational environment where technology is not just an auxiliary tool, but an integral part of the teaching and learning process.

For future work, it is suggested to conduct longitudinal studies on the impact of educational robotics on students' academic development and professional careers, providing insights into the skills acquired and their influences on educational and professional trajectories. In addition, a comparative analysis between different regions and socioeconomic contexts can identify inequalities and propose strategies to ensure equitable access to educational technologies.

Another suggestion involves the development of continuing education models for teachers, designing and evaluating specific programs for the use of digital technologies and robotics in education. Investigating the impact of these technologies on the inclusion of students with special needs, improving their participation and academic performance, also presents itself as a promising area.

Case studies on the implementation of technologies in public and private schools can examine best practices and identify specific challenges faced in each context. In addition, evaluating partnership programs between schools and technology industries can enrich the school curriculum and prepare students for the job market. Finally, investigating the impact of gamification on student engagement and learning at different levels of education can offer valuable insights for the application of digital technologies in education.

Thus, the integration of digital technologies and educational robotics represents a promising path for the evolution of education. With the continuous commitment of all actors involved and the overcoming of existing challenges, these technologies have the potential to create a more efficient, inclusive educational environment prepared for the demands of the future. This work contributes to the understanding of the impacts and challenges of this integration, offering a solid basis for future research and educational practices.

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