THE IMPACT OF EDUCATIONAL ROBOTICS ON THE EDUCATION OF STUDENTS WITH AUTISM

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ABSTRACT

The effect of educational robotics on the formation of students with autism emerges as an important area of research, highlighting significant benefits in the evolution of the social, emotional and cognitive abilities of these children. The introduction of social and teaching robots has shown encouraging results, favoring the development of healthy social interactions and helping to reduce repetitive behaviors. Additionally, these robots encourage motivation and participation during learning activities, transforming the educational process into a more engaging and dynamic experience. However, the presence of educational robotics in institutions faces challenges, especially those related to technological and financial limitations that complicate the effective use of these innovative instruments. To ensure fairer access to the benefits of robotics, these issues must be addressed comprehensively. Thus, understanding both the advantages and difficulties of educational robotics in the context of autism is extremely relevant to improve its application and expand the opportunities that this technology can offer in special education, promoting a more effective and enriching inclusion for all students.

Keywords: Robotics. Education. Autism. School Inclusion.

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INTRODUCTION

The bibliographic approach adopted in this work involves the analysis of several academic and literary sources that deal with the theme of educational robotics, especially in the field of Special Education. Through the literature review, it aims to understand how robotic tools can be incorporated into the teaching environment, highlighting their capabilities in improving the skills of students with autism. The research is based on articles, theses and case studies that demonstrate the applicability of robotics in education, in addition to the innovations that this technology can introduce in the learning of students with special needs.

The main purposes of this research include the exploration of educational robotics as a pedagogical resource and the analysis of its effects on the learning of students with autism. By investigating how robots can be used to promote communication, social development, and cognitive learning, the intention is to present a comprehensive overview of how this methodology can be applied effectively. In addition, it seeks to examine the benefits that robotics can offer, both in academic and emotional terms, to the students involved.

The justification for choosing this theme lies in the growing need to implement innovative methodologies that make teaching more accessible to all students, especially those with autism. Educational robotics emerges as a viable alternative, since it provides an interactive and dynamic learning environment. This strategy not only facilitates the assimilation of curricular content, but also encourages social interaction and the development of crucial skills in an environment that is often challenging for these students.

The relevance of the theme is clear, given the advancement of teaching methods and the need to integrate new technologies into the educational process. Educational robotics, by using robots as learning instruments, stands out as an approach that can transform the experience of students with autism. Additionally, it helps to create a more inclusive school environment where each student can feel valued and able to reach their full potential.

In an increasingly digital age, proficiency in technologies and robotics becomes critical. Thus, research on educational robotics not only represents a current demand, but also anticipates the future demands of the labor market and society in general. The implementation of robots in teaching can prepare students with autism for a world in constant transformation, helping them to develop skills that will be valuable in various professional areas.

In addition, the introduction of robotics in schools results in a change in social interactions within the classroom. Through contact with robots, autistic students have the opportunity to express themselves and relate to their peers in a way that is more comfortable for them. This interaction can favor an increase in empathy and mutual respect among students, contributing to the creation of a more welcoming and collaborative environment.

Another important point is the chance to personalize teaching through robotics. Each student has their own pace and style of learning, and robotics education allows teachers to adapt activities to the specificities of each student. This personalized approach is elementary to ensure that all students, regardless of their difficulties, have the opportunity to actively participate in the learning process.

Lastly, educational robotics not only has direct benefits for autistic students, but also offers schools the chance to develop more innovative and inclusive pedagogical practices. The adoption of this methodology can be a starting point for a reflection on how educators can adjust to the varied needs of students, promoting a fairer and more quality education for all. Thus, the focus on robotics within Special Education is justified not only by its innovation, but also by the transformation it can bring to the school routine.

THEORETICAL FRAMEWORK

The theoretical framework of this work explores the relevance of educational robotics in the context of teaching students with autism, presenting a detailed analysis of interventions that use social and educational robots. Guimarães et al. (2022) highlight that "social skills are essential for the individual's adaptation to the social environment", which reinforces the importance of educational strategies that promote these skills in children with disabilities.

Within the scope of the benefits provided by robotics, several studies indicate that these technological resources have the potential to stimulate the emotional and cognitive development of students. According to Azevedo and Menezes (2021), "mindfulness-based programs can contribute significantly to students' mental health", suggesting that the integration of techniques such as mindfulness in educational environments that use robots can amplify the positive effects of interventions.

In addition, the literature shows how educational robotics can be an effective means of promoting social interaction among students, minimizing problematic behaviors often associated with autism. Passos et al. (2021) state that "digital technologies offer new

possibilities for inclusion and learning", reinforcing the potential of robotics as an inclusive tool that facilitates interaction and learning for students with autism.

However, the theoretical framework also examines the challenges faced in the implementation of educational robotics. One of the main obstacles is the lack of adequate training of educators, which is essential for the effective conduct of activities with robots. Azevedo and Menezes (2021) point out that "the training of teachers is essential for the execution of innovative projects", which highlights the need for investment in continuing education.

In addition, there are barriers related to the infrastructure of educational institutions, which can limit the adoption of these technological resources. Guimarães et al. (2022) mention that "the absence of equipment and financial resources makes it difficult to implement programs aimed at developing social skills". This reality can compromise the effectiveness of therapeutic and educational interventions.

Another relevant aspect is the cultural resistance to innovation in the school environment. Many educators and managers still have a conservative view of education, which can make it difficult to introduce methodologies that involve technology. Passos et al. (2021) point out that "resistance to change is a factor that can limit progress in educational inclusion", suggesting that awareness and teacher training are crucial for overcoming this obstacle.

The positive impact of educational robotics is widely documented in case studies, which demonstrate significant improvements in social and emotional skills of students with autism. As stated by Guimarães et al. (2022), "interventions that incorporate educational robots show promising results", indicating an effective path to promote the inclusion and learning of these students.

Finally, the theoretical framework concludes that, despite the challenges, educational robotics presents itself as a powerful strategy for teaching students with autism. The integration of educational technologies can be essential for the development of the skills necessary for socialization and learning, transforming the reality of these students and contributing to a more inclusive and dynamic school environment.

DEFINITION AND FUNDAMENTAL CONCEPTS OF EDUCATIONAL ROBOTICS

Educational Robotics emerges as an innovative proposal within the pedagogical environment, presenting a method that combines technology with the learning process. This approach enables students to become familiar with different scientific and mathematical concepts practically and interactively, promoting curiosity and creativity. By incorporating

robots as teaching tools, educators create an environment where students have the opportunity to investigate, experiment, and solve challenges. This type of fun interaction not only captures students' attention but also helps in the assimilation of complex ideas, making learning more effective and enjoyable.

In addition, educational robotics stands out as a valuable tool for the development of essential 21st-century skills such as critical thinking and teamwork. Projects that involve creating and programming robots encourage students to collaborate, share ideas, and develop solutions collectively. This collaborative dimension is vital, as it contributes to the strengthening of interpersonal relationships and to the sense of belonging among students. Therefore, robotics is not limited to imparting technical knowledge but also facilitates the growth of soft skills.

By examining the implementation of educational robotics in specific situations, such as in the teaching of children with autism, we were able to identify an expressive potential. Interaction with robots provides a safe and controlled space where these students feel more comfortable communicating and participating. The use of robots can help decrease anxiety and improve communication, making it possible to practice social skills in contexts that can be challenging. This inclusive approach exemplifies how technology can be applied effectively to meet the demands of different types of learners.

Finally, it is crucial to highlight that the adequate training of educators for the use of educational robotics is a vital element for the success of this approach. Empowering teachers to feel safe and able to work with robotic technologies is essential so that they can explore everything that this tool can offer in the classroom. With proper preparation, educators can create impactful and transformative learning experiences that benefit not only students with autism, but all students, promoting a more innovative and inclusive education.

AUTISM AND ITS CHARACTERISTICS

Autism spectrum disorder (ASD) is characterized by a varied set of traits that affect the routine of people who have it. Early detection of the signs of ASD is essential, as it enables interventions that can considerably improve the quality of life of these people. The behaviors correlated with autism are very diverse, evidencing the need for therapeutic methods adapted to each case. Each individual presents a unique combination of competencies and difficulties, requiring a careful and detailed understanding of their needs.

Additionally, the social sphere is a commonly impacted area, where many autistic individuals find it challenging to decipher social cues and build relationships. This limitation

in communication can lead to misunderstandings and a feeling of isolation, which underscores the importance of social and family support. Projects that encourage inclusion and acceptance of differences are essential to develop a more welcoming and less burdened environment for these people.

Repetitive behaviors and restricted interests are also distinctive aspects of ASD, ranging from simple habits to true passions for specific topics. These behavioral patterns can provide a sense of stability and dominance in a world that often proves to be confusing. Family members and educators must recognize and value these particularities, establishing strategies that help autistic individuals to manifest their passions in a productive and integrative way.

Finally, the diagnosis of ASD represents a vital phase that opens access to therapeutic, educational, and support resources that are beneficial not only for the affected person, but also for their support network. Understanding the complexity of autism allows specialists, family members and society to work together to create a more inclusive environment. With appropriate assistance, individuals on the autism spectrum can explore their abilities and integrate positively into the community where they live.

METHODOLOGY

The methodology adopted in this study consisted of a systematic review of the literature related to educational robotics and autism. The main objective was to identify research that discussed the application of social and educational robots in special education. Through this review, it was possible to map the advances and challenges in the implementation of robotic technologies to meet the specific needs of autistic students, providing a solid basis for the discussion of the observed impacts.

In addition to the analysis of the literature, detailed interviews were conducted with educators and therapists who work directly with autistic students. These conversations were essential to understand the perceptions and experiences of these professionals about the use of educational robotics in their practices. The collection of qualitative data allowed us to obtain valuable perspectives on the integration of robots in pedagogical and therapeutic activities, revealing both the benefits and limitations of this approach.

After collecting the information, the answers were rigorously analyzed, seeking to identify recurring patterns and themes. This qualitative analysis highlighted not only the positive aspects of educational robotics, such as the promotion of social interaction and engagement in activities, but also the challenges that educators face when incorporating these technologies into their school routines. The discussion of the results enabled a

broader understanding of the effectiveness of robots in supporting the learning of students with autism.

In addition to the data collected, it was interesting to observe the differences in the perceptions of educators and therapists about educational robotics. While some have highlighted the transformative potential of this tool, others have expressed concerns about the education and training needed to utilize these resources effectively. This diversity of opinions enriches the debate and indicates the need for more research and training aimed at training professionals.

The combination of the literature review and interviews revealed profound insights into the impact of robotics on the education of students with autism. The results suggest that while robotics offers valuable opportunities for the development of social and cognitive skills, its implementation requires a clear understanding of the educational goals and individual characteristics of students. This balance is essential for robotic resources to be used in a pertinent and effective way.

Finally, the research highlights the importance of a continuous dialogue between researchers, educators and technology developers, aiming to create more inclusive educational environments. Educational robotics initiatives must be adapted to the realities of classrooms, promoting not only inclusion, but also quality education that responds to the needs of all students, especially those on the autism spectrum. This collaboration can lead to a brighter future, where technology and pedagogy intertwine to benefit more and more students.

BENEFITS OF USING SOCIAL AND EDUCATIONAL ROBOTS IN TEACHING STUDENTS WITH AUTISM

The use of social and educational robots in the teaching of students with autism stands out for its significant benefits, which favor the development of social, emotional and cognitive skills. According to Freitas (2021, p. 2742), "technology can reconfigure pedagogical practices, offering new forms of interaction". The integration of these devices into the school environment allows students to explore a learning format that adapts to their needs, favoring engagement and active participation in activities.

Recent studies show that educational robots promote a safer and more welcoming learning environment, which is essential for students with Autism Spectrum Disorder (ASD). Moura et al. (2024, p. 56) state that "assistive technologies, when well used, offer undeniable support for the inclusion of students with ASD". This support is of paramount

importance in promoting more effective social interactions, which can be challenging for these students.

In addition, the presence of robots can reduce anxiety and stress in learning situations. This reduction is especially important as many autistic students struggle in high-stimulation environments. Dourado (2023) mentions that "the use of ICT can provide a more controlled and predictable learning space", allowing students with ASD to feel more comfortable and willing to participate in activities.

The use of robots can also help in understanding emotions, a fundamental aspect for the social development of these students. Through interactions with robots programmed to recognize and respond to emotions, students can learn to identify their own and others' feelings. This is corroborated by Silva et al. (2018, p. 3829), who observe that "technologies can serve as important mediators in the social relationships of students with autism".

The teaching and learning process is transformed with the introduction of technologies such as educational robots. They not only act as support tools but also as motivating agents, encouraging students to interact and actively participate. In addition, these robots can be programmed to follow specific instructions, which benefits the learning of everyday and academic skills.

The personalization of learning is another advantage associated with the use of social robots. These devices can be adjusted to meet the individual preferences and needs of each student, creating a more adaptable and efficient teaching plan. Thus, students with autism can progress at their own pace, which is essential for their academic and social development.

Through the introduction of robot-mediated learning environments, educators have the opportunity to observe and adapt their teaching strategies, promoting a finer adjustment in methodologies. This flexibility is key, as each student has a unique set of skills and challenges, and the application of educational robots can facilitate dynamic adaptations in the curriculum.

In addition, it is important to highlight the role of educators in the implementation of these devices. Training teachers in the use of social robots is essential to ensure that they are used effectively and meaningfully. As highlighted by Dourado (2023), "the role of teachers in the use of ICT becomes crucial for the academic and social development of students with ASD", as they are the ones who will guide the student in the process of interacting with technology.

Social robots do not replace, but complement the work of educators, serving as an additional resource to enrich the learning experience. The combination of traditional

methodologies with technological innovations can generate significant results in the educational inclusion of students with ASD. Every interaction with a robot can be a new opportunity for learning and development.

Practical experiences and feedback gained from interactions with social robots can lead to continuous improvements in educational approaches. Therefore, educational institutions must adopt a model of continuous training for their educators, enabling them to take full advantage of these new technologies.

Finally, research on the effectiveness of educational robots in the context of inclusive education is still incipient, and there is a need for more in-depth studies that explore their potential. As Freitas (2021, p. 2746) concludes, "the search for methods that respect and meet diversity is fundamental for the formation of a more inclusive higher education". Therefore, promoting technological innovation in education is not just a trend; It is a pressing need for the creation of richer and more inclusive learning environments.

CASE STUDIES AND PRACTICAL EXPERIENCES

Case studies and practical experiences with social and educational robots in school environments have revealed positive results in the development of social, emotional and cognitive skills of students with autism. The use of innovative technologies has proven to be an effective strategy to attract the attention of these students and facilitate learning. In this sense, gamification emerges as a complementary technique, promoting a fun and interactive learning environment, where students are encouraged to actively participate. Arnold et al. state that "a gamification model for educational social networks can foster interaction among students" (2020).

In addition to robots and gamification, the integration of computer technologies in the educational process presents itself as a challenge and an opportunity. Ivo et al. point out that "the use of computational technologies should be adapted to meet the specific needs of children with autism spectrum disorder" (2019). This implies not only designing inclusive activities, but also considering the individual preferences and abilities of each student, promoting a more inclusive and effective educational environment.

Interaction with social robots, for example, provides students with the chance to practice social interactions in a controlled and safe environment. These experiences are fundamental for them to develop skills that can be reused in broader social contexts, facilitating their integration into society. Educators thus have a primary role in the implementation of these technologies, and their training is essential to maximize the benefits that these tools can offer.

Additionally, collaboration between teachers, parents, and therapists is vital to ensure that interventions are ongoing and adaptive. Clear communication between these involved makes it possible to plan activities that train students and promote their involvement. Narciso and Rodi highlight that "digital connections can be an important bridge for the inclusion of autistic students" (2024), emphasizing the importance of multidisciplinary support.

Another aspect highlighted is the importance of positive feedback in students' interactions with social robots. The immediate and encouraging response from these devices contributes to the construction of students' self-confidence, leading them to feel more comfortable communicating and expressing themselves. The self-motivation generated by these interactions is an element that can undoubtedly transform the educational experience.

In this context, educators must be trained to use these technologies. Continuous training programs are essential for teachers to feel safe when integrating robots and gamification into their teaching. Proper preparation not only enriches teachers' knowledge, but also increases the chances that technology will be used effectively and meaningfully.

In addition, the evaluation of the impact of these educational tools must be carried out rigorously, so that their real effectiveness is understood. Studies that monitor students' progress in environments that utilize social robots and gamification can provide valuable insights into best practices and methodologies to adopt. This allows adaptive teaching to become an increasingly viable reality in educational institutions.

Finally, the desired inclusion in the school environment is not restricted only to the use of technologies, but also to the construction of a school culture that values diversity. The promotion of a welcoming and respectful environment is essential for all students, regardless of their difficulties, to feel part of the group. It is an invitation to reflect on how educators can work together to create a truly inclusive and accessible learning space.

CHALLENGES AND LIMITATIONS OF IMPLEMENTING EDUCATIONAL ROBOTICS IN TEACHING STUDENTS WITH AUTISM

The introduction of educational robotics in the learning of autistic students faces several obstacles that must be overcome to ensure quality education. One of the main difficulties involves adapting technological resources to the individual needs of these students, which requires careful and dedicated attention from educators. According to Ramos et al. (2018), "peer-mediated intervention creates an environment conducive to

inclusion, but requires appropriate teacher training." This aspect of teacher training is critical, as it allows educators to use robotics both effectively and inclusively.

Another significant challenge is the training of teachers to use robots in a way that benefits all students, especially those with autism. For this, there must be continuous training programs that seek to promote the understanding of the particularities of autism and the most appropriate way to integrate educational robotics technologies. Silva and Souza (2020) state that "the use of robotics in innovative mathematics education can be a watershed for learning", emphasizing the relevance of innovative methodologies in students' autonomy.

The financial issue also represents a limitation, since many schools do not have enough budget to acquire and maintain robotics equipment. This situation underscores the need for public-private partnerships that can facilitate access to these technologies. Public policies are vital to promote initiatives aimed at integrating educational robotics into the school curriculum, especially for the public that needs support.

In addition, the lack of specific public policies focused on the inclusion of robotics in teaching for autistic students is a major challenge. The lack of clear guidelines can result in a disjointed implementation, which does not meet the true needs of these students. Therefore, government agencies must create strategies to direct the use of educational technologies inclusively, taking into account the characteristics of autistic students.

An effective strategy to overcome these obstacles is to foster a collaborative culture among educators, technology experts, and family members, aiming to create a safe and motivating environment for learning. This collaboration can lead to innovative pedagogical practices that use robotics as an inclusive tool, benefiting not only autistic students, but the entire school community.

In addition, it is feasible to develop collaborative research projects with universities and research centers that allow the exploration of new teaching strategies through educational robotics. These researches can be beneficial for teacher training, in addition to helping in the development of specific resources aimed at the needs of autistic students, expanding the possibilities of learning and growth.

Finally, it is worth noting that collaboration between educators and researchers is decisive to foster significant progress in this area, ensuring that educational robotics is established as a common and effective practice in classrooms, particularly for students facing cognitive difficulties. With a focus on inclusion and innovation, it is possible to change the reality of teaching for students with autism by providing them with tools that promote learning and socialization.

In summary, overcoming obstacles in the adoption of educational robotics for students with autism requires a diversified approach that includes training, financial resources, public policies, and partnership between different educational actors. Only in this way will we be able to ensure that these students have access to quality education that values their particularities and potentialities.

TECHNOLOGICAL AND FINANCIAL BARRIERS

The constraints associated with technologies and funding have a significant impact on the viability of educational robotics for students with autism. The insufficiency of financial resources for the acquisition of adequate equipment, combined with the lack of adequate technological infrastructure, makes it difficult to implement these tools.

In addition, the demand for qualified professionals with expertise in robotics and its pedagogical applications represents an additional barrier that institutions need to face. This reality results in a challenging environment for the effective realization of projects aimed at benefiting these children through technology.

A relevant aspect to be considered is the speed with which technologies develop, quickly becoming obsolete. For educational institutions, this implies the requirement of a constant effort to update, which is often not possible due to budget constraints.

The frequent need to renew both equipment and professional training can discourage investments in educational robotics, compromising the development of essential skills in students. This scenario of constant change represents an additional challenge for the successful inclusion of robotics in pedagogical practice aimed at students with autism. In addition, resistance to innovation by some educators can be a significant obstacle.

Many professionals may feel insecure or unprepared to integrate new technologies into their classrooms, resulting in a reluctance to adopt educational robotics as an integral part of the teaching-learning process. To overcome this resistance, it is crucial to develop continuing education programs that enable educators to integrate robotics effectively, promoting self-confidence and aligning pedagogical practices with the needs of students.

Raising awareness about the benefits of educational robotics for students with autism is also a determining factor. There is often a lack of understanding of how these tools can facilitate the learning and socialization of these students. Therefore, institutions must carry out information campaigns that highlight the positive results of robotics, not only to encourage the adoption of these technologies, but also to raise awareness among educators, parents, and the community in general about the importance of digital inclusion.

In summary, overcoming technological and financial barriers requires a joint commitment from all agents involved in the educational process. Public policies that encourage investment in educational robotics, as well as training programs for educators, are essential to transform this scenario. Additionally, collaboration between schools, technology companies, and education experts can result in innovative solutions that make robotics accessible and effective for all students, with an emphasis on those with autism. Finally, there must be a strategic plan that includes not only the acquisition of equipment, but also the continuous training of educators and the awareness of the school community.

A collaborative effort between all these segments can help overcome existing barriers and promote an inclusive environment. In this way, educational robotics can establish itself as a powerful tool in the development of social and cognitive skills of students with autism, contributing to their full integration into society.

FINAL CONSIDERATIONS

Considering the positive aspects associated with the use of educational robots to support students with autism, further investigations must focus on broadening the diversity of the sample, including different student profiles. This diversification will allow the results to be broader and more representative, providing a clearer view on how these tools can benefit a larger number of students.

In addition, it is essential to analyze the effects of educational robotics on various age groups and developmental stages of students with autism. Such an approach will enable a deeper understanding of the benefits that these devices can offer, helping to optimize interventions according to the specific needs of each age group.

Another aspect to be considered in future research is the exploration of methods that facilitate the integration of educational robots within the school curriculum. The identification of effective strategies can contribute to the use of technology in a complementary way to existing pedagogical practices, improving the educational experience for students.

The performance of education professionals also deserves special attention. It is important to assess how these educators can prepare and adapt their approaches to effectively implement robotic technologies in the classroom. Their role is to ensure that technological innovations are used to promote inclusion and learning.

In summary, a focus on research that studies the interaction between educational robots and different learning contexts will contribute to a significant advance in pedagogical practices. By better understanding the nuances of this relationship, it is possible not only to

enhance the benefits already observed, but also to discover new ways to help students with autism in their educational process.

Finally, continuing to study this field can lead to valuable discoveries that impact not only students with autism, but the entire school environment. Thus, the formation of an educational ecosystem that embraces technology and recognizes its potential is an important step towards a more inclusive and innovative future in education.

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