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(Review Article)

The use of robotics in the education of students with special educational needs

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Abstract

The increasing number of children with special needs requires the improvement of methods in education by reducing the barriers to learning. Some research conducted on students with special needs concluded that students were ready to plan, initiate, and continue even a difficult project. In this sense technology can offer all students new possibilities, possibilities to learn and practice various important cognitive and social skills. There are indications that children with Special Educational Needs, with the help of educational robotics, have managed to maintain their attention and increase their participation in the educational process.

Keywords: Robotics; Special Education; ICT

1. Introduction

In modern, constantly developing and technology-based societies, learning new technologies is a priority (Manola et al., 2023; Vouglanis et al., 2022; Voyglanis & Driga, 2023). A new technology is robotics. Robotics combines elements of software development, artificial intelligence, advanced engineering and the study of human behavior. At the same time, its first integrated applications appear in sectors such as industry, medicine, aviation, thus affecting people's daily lives. Thus, little by little, robotics was included in education, with the result that students of all grades show a special interest in robotics and express excitement when they come into contact with robotics applications. The main tool of educational robotics is the programmable robot, which embodies an entity endowed with autonomy that is able to fulfill specific missions in a changing environment (Raptis & Rapti, 2014).

Educational robotics covers various subjects, while at the same time the concept of programming is taught. This creates a learning environment in which children can interact with their environment and work on real-world problems. Educational Robotics can be a great tool for children to gain building experiences (Alimisis, 2013). Children with the help of robotics can learn science, engineering, technology and mathematics, acquire not only social skills but also design, communication and creativity skills (Johnson, 2003). Educational robotics requires building and programming a robot to perform a task. Children with typical development, according to the literature, can meet these requirements (Terzidis et al., 2009), while the indications are also positive in special education (Pennisi & al., 2016).

2. Educational robotics and students with special educational needs

Educational robotics has the potential to add value to special needs education and this is demonstrated by the fact that children using educational robotics have already successfully negotiated various barriers to learning. The interest and enthusiasm that children show when developing and building robots through programming has actually resulted in the disappearance or improvement of some typical learning difficulties. For example, children with attention deficits have been observed to focus on a robotic construction (Andruseac et al., 2015), while children with social adjustment difficulties interact with each other under the same conditions (Anagnostakis et al., 2008).

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Various researches have been carried out on the effects of educational robotics on people with special needs. More specifically, a first-phase study was conducted in Finland from September 2005 to May 2007. The children who participated in the study were children with special needs, aged four (4) to six (6) years old, who engaged with Lego Mindstorms NXT and the Topobo robots. The children built and programmed the robots in the technology labs. The second phase of the study was conducted at the University of California San Diego2 in 2008 and involved young children playing with a social robot. Preliminary results of the first phase of this research concluded that the individual needs of children present a challenge to robotics. These challenges can be used as a resource for designing the robot. Also, robotics as a learning tool can help children overcome barriers to learning. This happens when this medium is designed in such a way that it can respond to the individual interests of children and support a child who functions as a constructor and creator of knowledge (pedagogical model). Finally, physical access to the robot influences the child's sense of emotional ownership and connection to the robot. These two factors together contribute to the successful achievement of various learning objectives, such as the possibility of long-term work and collaborative interaction in special needs education. Preliminary research findings confirm that robotics based on construction and programming can provide appropriate learning tools for kindergarteners between the ages of four and six in primary school. These educational kits severely exclude autistic and young children, who could nevertheless benefit from the application of robots in education. Therefore, the hypothesis is that these users could benefit from a social humanoid robot (Virnes, 2008).

Another qualitative study was carried out in the laboratory of the University of Joensuu, where the technology courses took place. The frequency was approximately once a week from September 2006 to May 2007. Each session lasted approximately 1 hour and 40 minutes. The robots used were Topobo and LEGO Mindstorms® NXT (NXT). The research participants were a group of eight 5th and 6th grade boys between the ages of 10 and 14 and their teachers who participated as tutors during the lessons. The students who took part in the research were diagnosed with various learning disabilities, Attention Deficit Hyperactivity Disorder, high functioning autism spectrum disorder (Asperger type) and language disorders such as dysphasia. The course structure included an introduction with discussion, hands-on work with robotics, writing a weblog entry, and a comprehensive discussion held in a circle. The discussion at the beginning of the lesson included the reminder about the next phase of the project and comments about the general themes and about the work. At the end, a round of discussions was developed in which the children were asked to describe the progress of their work. The task of teachers and researchers was to support and guide children's independent work. The researchers to draw safe conclusions and data used digital video recording as the main method of data collection. In order to prevent the researchers from being influenced by the data collection, a research assistant was assigned to videotape the lessons (Virnes et al., 2008).

The results of this research were that building bricks had an effect on children's progress. While most of the children found it easy to build robots using the NXT Instruction Manual, without the manual it was too difficult for most of them. Their difficulties may have been due tdo the fact that they had to master a new method of construction, which involves placing bricks together via a joint instead of directly placing them, which is characteristic of LEGO® RIS bricks. The children followed the instructions precisely without any difficulty, but this limited them to avoid any variations on the robot. The same situation was evident with programming. The children were able to create program work just by following exactly the NXT programming with computer instructions. Also, a simple image of a Topobo robot was an insufficient basis for construction, and for this reason attempts to build a robot similar to a photo were often unsuccessful. Sometimes the teaching book led the children to wrong perception. So the bottom line for building the robot was that most kids need detailed instruction in both building and programming NXT robots in order to show some progress. In Topobo's case, instructions were unnecessary. Topobo himself shaped the project and inspired some of the children. It was also evident that adult intervention was necessary even if the interaction with the bricks led the children to construction processes. It is important to note that this intervention inspired some students to work through the difficult phases. Difficulty finding the right brick for a particular purpose was the most common problem children faced during construction, even though the number of bricks available was quite limited. In addition, children were often annoyed when they inserted a faulty item into a robot or when it got stuck somewhere. A disappointing experience led some of the children to abandon their original plan and consider a new building project. Of course, it was easier to change the programming with the self-designed Topobo models than it was with NTX. The more the child worked on the construction, the easier it was for him to accept the necessity of the reconstruction required by a mistake and the easier it was for him to solve the problem with the help of small feedbacks from the adults. It was noted that when children only worked for a short time with the robot, they tended to give up more easily and this weakened their desire to solve unavoidable problems (Virnes et al., 2008).

This study focused not only on educational robotics but also on the requirements of children with special needs. A variety of new approaches to kit design are proposed for the education of children with atypical development, as well as tools to make programming easier to learn. Of course, the characteristic needs of these children also apply to general education, but they are more important in special education. As for the designers of educational kits, they can use these approaches as a reference point for adapting the available technologies for different categories of users by increasing the possibility of direct interaction between children (in general) and the technology. Also, they need to collect information from children in real situations. Therefore, it became apparent to the researchers during the study that creatively adapted technologies can improve the quality of special education.

A pilot study conducted evaluated a new intervention aimed at reducing social anxiety and improving social and occupational skills for adolescents with autism spectrum disorders. The intervention drew on participants' shared interest in robotics to facilitate natural social interaction between individuals with autism and their typically developing peers. Eight individuals with autism and eight typically developing individuals of the same age, twelve (12) to seventeen (17) years old, participated in a one-week robotics camp, during which they learned robotic events, actively programmed into an interactive robot, thus learning skills "career". The group with the students with autism showed a significant reduction in social anxiety, while at the same time both groups showed an increase in knowledge about robotics. Of course, no group showed a significant increase in social skills. These initial findings reveal that this approach is promising and warrants further analysis and study (Kaboski et al., 2015).

Of course, educational robotics has also appeared in the form of humanoid robots, mainly helping students with Autism Spectrum Disorders (ASD). One question raised in educational robotics research is whether social robots can be a useful tool in autism therapy. A systematic review has discovered the many positive effects of using social robots in therapy. For example, autistic subjects often perform better with a robot partner rather than a human companion. People with Autism Spectrum Disorders sometimes displayed behaviors towards robots that typically developing people had towards people. People with autism had many prosocial attitudes towards robots. during robotic sessions, they showed reduced repetitive and stereotypic behaviors and with the help of social robots they were able to improve spontaneous language during therapy sessions (Pennisi et al., 2016). Therefore, robots provide therapists and researchers with a means to educate children with autism in an easier way, but studies in this area remain insufficient. It is necessary to clarify whether the gender, IQ and age of the participants influence the treatment outcome and whether any beneficial effects occur only during the robotic session or remain observable outside the clinical/experimental context.

At this point it is important to mention the effect of educational robotics on people with mental retardation. More specifically, a total of five groups of students participated in a survey. The groups differed from each other in age, level of education and individual needs. Because, they were aged eight (8) to ten eight (18), the four groups included people with special needs from primary schools and the fifth group people from professional special education and their individual difficulties ranged between learning difficulties and mild mental retardation. delay. All students could develop their speech, but they had difficulties mainly in reading and writing, as well as in self-directing their actions. The number of students per group varied between seven (7) and ten (10) students. Each technology lesson took place for two hours, every other week from September 2005 to December 2005. Four of the groups had lessons in school and one group in an educational technology laboratory at the university. There were at least one or two teachers, an assistant and two researchers per group who trained and taught the students during the technology lessons. The systems used to create a physical artifact were the LEGO Mindstorms 2.0 Robotics Invention System and ELEKIT building sets. The students implemented their own projects at their own speed and with minimal intervention from the adult participants. The teaching was carried out with special attention to the individual needs of the students. Creative and great student activities were highly encouraged and supported. Systematic observation and interviews of teachers and assistants were the main means of data collection. In addition, teachers completed an observation form after each lesson and students were interviewed informally during the sessions. The analysis of the data was based on inductive analysis and with selected tools. The results of this research were that programming was more of a challenging phase, which required more support, but increased students' enthusiasm and opened the possibility to control the creation of a technological solution by the students themselves. The playful and inspiring technology environment encouraged students to try new things and be creative. Working with educational robotics provided a natural learning environment for problem practice, skill solving, logical thinking, persistence, concentration and frustration tolerance. As the students had no experience of failure or difficulties when starting to work with the new Technology, they were ready to plan, start and continue even a difficult project. In this sense technology can offer all students new possibilities, as well as possibilities to learn and practice various important cognitive and social skills. The learning tool and activities were new to the students, so some results such as strong motivation and enthusiasm were partly a consequence of fascination and novelty. The second phase of the research investigated the effects of the innovation factor on research results. Technology was implemented based on each student's personal curriculum and lessons (Karna-Lin et al., 2006).

3. Conclusion

In conclusion, as it became clear from the above researches, educational robotics can reveal new hidden potentials and skills that students with special needs have. It also allows for the use of different learning styles and the use of multiple senses, which are essential for students with non-typical development. Educational robotics offers new possibilities and skills to students with special needs. A robot technology used to teach subject-specific content or designed to function as a programming tool promotes learning. [17-29] Finally, robotics in education acts as a tool that encourages children to implement their own ideas, thus developing their creativity and imagination.

Finally, it's critical to emphasize how beneficial and productive all digital technologies are for the field of education. The use of these technologies, which include mobile devices (30-34), a range of ICT apps (35-47), AI & STEM ROBOTICS (48-54), and games (55-57), facilitates and improves educational processes including evaluation, intervention, and learning. Additionally, the use of ICTs along with theories and models of metacognition, mindfulness, meditation, and the development of emotional intelligence [58-92], accelerates and improves educational practices and outcomes, especially for Special Education Needs Students.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors proclaim no conflict of interest.

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