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Programming Robots in Kindergarten

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Abstract

Children at an early age easily acquire new technical and technological knowledge, and their abilities and skills surpass all expectations. Nowadays, children are already familiar with and interested in new technologies from a very young age, as it is an integral part of everyday life and has great potential for future development. In light of this, programming robots in kindergarten emerges as a very relevant and popular topic, which is precisely the subject of this paper.

Keywords: robotics, preschool age, robot programming, kindergarten

What is robotics?

Robotics is a multidisciplinary and interdisciplinary science and technology that deals with the research, development, design, and application of robots. It is a field that encompasses applied engineering sciences (mechanical engineering, production engineering, electrical engineering, electronics), computer science, as well as mathematics and mechanics (Milutinović, 2015).

The word "robot" originates from the Czech word "robota", which means forced labor. This term was first introduced by Czech science fiction writer Karel Čapek. According to the definition found in Webster's dictionary, a robot is an automated device that performs functions typically attributed to humans. The official and more precise definition provided by the Robotic Industries Association (RIA), which applies to industrial robots, can be translated as follows (Potkonjak, 2016): "An industrial robot is a multifunctional manipulator that can be reprogrammed and is intended to move work material, objects, tools, and special devices in various prescribed ways in order to perform different tasks."

In today's time, children are exposed to technology on a daily basis, which is why it is important to enable them to learn what lies behind the screens they use every day. They need to discover what drives that entire system they interact with while watching various cartoons, playing games, using social networks, and a range of other applications. Robotics is often equated with computer science and programming. However, it is important to note that automation and robotics are not part of the field of computer science or general computer literacy. Although programming robots falls under the domain of computer science, the technical aspect emphasizes the function, development, and construction of the robot itself. Robotics is a highly complex field, and therefore, the technical aspect takes a systematic problem-solving approach that simultaneously pays equal attention to the whole, while the computer science aspect emphasizes an algorithmic way of thinking based on understanding, analysis, and programming solutions (Padovan, 2018).

Development of robotics and the use of robots in educational institutions

Throughout history, humans have always strived to build machines that resemble them. There is no precise definition that can determine what a robot is. For robots that physically resemble humans, they can be described as machines designed to fully or partially replace humans in tasks. The development of robots and robotics is closely linked to the development of computers, mathematics, electronics, and electrical engineering. Based on the level of autonomy, interaction capabilities with the environment, and intelligence, several generations of robots are distinguished. The first generation includes programmed robots whose control process is carried out in control chains. These robots do not use feedback information, and errors in guidance cannot be corrected. The second generation of robots includes robots with a set of sensors that serve to obtain feedback information about their own state and the state of the environment. This allows them to correct errors during execution and adapt to changes in the robot and the environment. The third generation comprises intelligent robots with the ability to learn, reason, and make conclusions. They can adapt to different environments and unforeseen situations. They have a high level of organization, functionality, and mobile autonomy. The development of personal robots has also stimulated the development of social robots with various purposes: performing household chores, educating children, caring for patients, assisting the elderly and disabled, entertainment, and other applications. The development of robots is constantly growing, and more and more humanoid robots are being developed (Nikolić, 2015). The use of robotic technology in schools is most prevalent in technical schools that have subjects related to robotics. However, it is necessary to introduce robotics education at an earlier age, even in kindergartens, as it enhances the quality of teaching and education, motivates children to use technology and science, and helps shape technical and social skills in children (Nikolić, 2015).

Programming robots in kindergartens

The essence of programming is to identify a problem and break it down into smaller parts. In theoretical terms, a problem can be a practical or mental situation for which a person tries to find a way or procedure to solve it. The solution to a practical problem is usually practical itself, such as a construction solution, while the solution to theoretical problems is mental or rational (Bratina, 2012). The concept of programming is automatically associated with computers and involves creating a series of instructions to perform a task. Due to its association with computers, programming is rarely seen as a rational problem-solving approach. Therefore, it is often considered something abstract, difficult to master and understand. Adults, in addition to having a weak understanding, fear possible errors, which are an integral part of programming. This often leads them to give up quickly, and as a result, programming is perceived as something reserved for certain individuals. Children approach problem-solving with less formality and tend to lean more towards play. It is also known that children's problem-solving abilities change depending on their age. Accordingly, the approach and problem-solving techniques should be adapted to the child's age. For children between the ages of three and five, involving emotions and creative play is recommended, while for slightly older children (between five and seven years old), the use of open-ended questions (situations) and various materials is more appropriate (How to teach Problem Solving strategies, 2019). This is why an approach through play is necessary for educating children in problem-solving and learning the basics of programming. Practice confirms that children, unlike adults, do not have an initial fear of making mistakes, especially when problem-solving is presented as a game. For this reason, didactic programmable robots are increasingly being used for initial introduction to programming. Affordable prices, easy usability, and practical design have made it possible to generate interest in programming and problem-solving with a focus on digital technologies even among the youngest children.

Didactic robots

There are several types of didactic robots, adapted to the age of children and the complexity of programming procedures. Their visual characteristic is their appealing and likable appearance, but in terms of didactics, it is much more important to focus on the possibility of control or programming, which must be tailored to the age of the intended children. For children aged four to five, it is recommended that control and manipulation of the robot be done through an application on a tablet or a similar mobile device. In simpler cases, it is possible to set the robot in a line-following mode, which children can draw freely with their hand. This way, children become familiar with the basic functions of the robot, but with certain limitations. This use doesn't make much difference be-

tween a robot and a remote-controlled toy. Therefore, it is advisable to provide a higher level – initial robot programming by setting thematic backgrounds or elements that direct and control the movement and behavior of the robot.

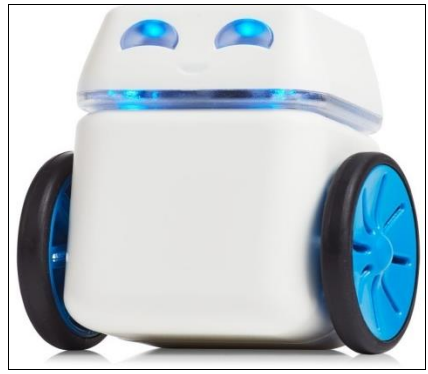

Figure 1. Didactic robot

For children aged five and older, it is more appropriate to introduce them to the first steps in programming. For this purpose, programming or code cards can be used, which visually represent the instruction (step) that the robot will execute (Figure 2). This approach is highly effective because children receive visual information about the future steps or movements of the robot and can theoretically verify the correctness of the proposed solution. At the same time, children understand that even simple movement is composed of a sequence of precisely defined steps (segments). Children receive immediate feedback on problem-solving by observing the robot's movement after it is activated. They can quickly identify and correct any errors by re-entering the programming steps, so to speak. If the robot's movement is correct, it represents a reward for the children and elicits a clear emotional reaction – enthusiasm. Problem-solving simultaneously stimulates their thinking, multiple actions, imagination, creativity, and encourages further exploration of the capabilities and features of the didactic robot.

Figure 2. Programming cards for the robot

The task of the educator is to introduce more complex problem situations and thereby raise the level of interest in the activity. Good examples include using thematic backgrounds or fostering a competitive spirit among the children, which can be observed in solving problems or tasks related to the movement and behavior of the robot.

Figure 3. Thematic backdrop for the robot

The essence of the robot activity on the thematic backdrop is for children to indirectly understand the robot's movements as a problem to be solved through small steps. In fact, children grasp that only when all the steps are properly combined, the robot will move as intended. In this way, children easily understand programming procedures.

Use of "bee bot" robot in kindergarten

The BEE BOT robot, shaped like a little bee, is very simple, appealing, and intuitive. This robot is an excellent tool for learning to solve simple problems and is easily applied in kindergartens. It can move forward, backward, left, and right. It doesn't have sensors, so it cannot "listen" to the environment or "see" whether the room is light or dark, whether there is an obstacle nearby, etc. It is great for taking the first steps in programming, but due to its limited capabilities, it is not an ideal choice for older preschool children.

Figure 4. BEE BOT Robots

BEE BOT robots are excellent for use in preschool settings. They are highly popular and loved by children due to their simple controls and friendly design. BEE BOT is a programmable robot designed for children aged 3 to 7 years old.

BEE BOT serves as an ideal starting point for teaching children programming. Working with BEE BOT introduces children to structured activities, develops their imagination, and offers a range of opportunities to explore cause and effect relationships.

Figure 5. Programming the BEE BOT

The importance of robotics for children

The importance of robotics for children is significant and diverse. Through robotics, it is possible to develop and strengthen perseverance and resilience in children. If the caregiver praises the child during the work process, it helps build perseverance. If the caregiver praises the child's final result and rewards them, it builds persistence and a desire to repeat that result Hilčenko (2022).

Therefore, the desired behavior we want to develop in children is achieved through praising the intermediate results of their work, as well as the final result, rather than just praising and rewarding the final outcome. Furthermore, robotics helps children acquire and strengthen their self-confidence. This aspect is achieved when the robot rewards the child every time they program it correctly. This reward given by the robot makes the child joyful and eager to learn more and progress by working on more complex tasks. The robot serves as an objective and unbiased evaluator. Through robotics, children also develop a sense of teamwork, cooperation, and communication. They develop their critical thinking skills and learn to advocate for their own ideas while respecting others' opinions through active listening. The importance of robotics for children is significant

and multifaceted. Here are some key aspects of the importance of robotics for child development:

Stimulates creativity and problem-solving skills: Robotics encourages children to think creatively and find innovative solutions to problems. They learn to analyze situations, think critically, and apply logical reasoning to overcome challenges.

1. Enhances STEM skills: Robotics integrates various STEM disciplines, including science, technology, engineering, and mathematics. Children develop a strong foundation in these subjects as they engage in hands-on activities that involve designing, building, and programming robots.

2. Fosters teamwork and collaboration: Many robotics activities involve teamwork and collaborative problem-solving. Children learn to work effectively in groups, communicate their ideas, and listen to others. They develop important social and interpersonal skills while achieving common goals.

3. Promotes persistence and resilience: Robotics projects often require trial and error, perseverance, and resilience. Children learn that failure is a natural part of the learning process and develop the determination to overcome obstacles and improve their designs.

4. Builds digital literacy and computational thinking: Through robotics, children gain exposure to technology and develop digital literacy skills. They learn to understand and use programming languages, algorithms, and logical thinking, which are essential in today's digital world.

5. Encourages curiosity and lifelong learning: Robotics sparks children's curiosity and enthusiasm for learning. It provides hands-on experiences that make abstract concepts tangible and relatable. This curiosity-driven learning mindset can extend beyond robotics to other areas of their lives.

6. Prepares for future careers: With the growing influence of automation and technology, robotics skills are becoming increasingly valuable in the job market. By engaging in robotics at a young age, children develop a foundation for future careers in fields such as robotics engineering, computer science, and AI.

Overall, robotics empowers children with essential skills and competencies that are vital for their personal and academic development, as well as for their future success in an increasingly technology-driven world.

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