

# Educational robots in preschool education

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**Abstract--Along with robot technology development, researchers and educators have employed robots to support the education. This paper gives an overview of using robots in education, describes the types of robots used in preschool education and the experience of utilizing robots in preschooler's everyday life - how successfully they learn, collaborate, share information, and master the basic concepts of programming as direct users of educational robots. Crucial importance is attached to robots that use tangible elements, objects that are visually accessible and offer to the young students an opportunity to manipulate.**

**Keywords: education, robots, communication, technology**

## I. INTRODUCTION

It is widely accepted that overcoming STEM competencies in preschool lead to faster development of cognitive abilities and the ability to solve problems that appear in children [14]. In this process, the educational robots used in the learning process is of great help. It gains wide popularity. Robots that take wide swing in education allow children to gain practical experience in accepting the constant changes in the living environment and adapting to them, as well as using the acquired knowledge in real-time situations.

## II. RESEARCH REVIEW

In recent years, robots used in the educational process to learn and master new content have become very popular tools, as the authors Causo and Chen [8] have pointed out in their paper. In particular, there is a growing interest in using tangible robots that are defined as physical manipulative that can directly affect and stimulate the digital environment in which we live. Author Bers [2] points out that tangible, manipulative robots are of particular interest in early childhood learning because they correspond to traditional learning toys created by Maria Montessori and Friedrich Frobel, designed to lead to gaining knowledge and learning mathematical concepts.

The authors in [17] suggest that tangible educational robots allow a child to enter digital information by manipulating with physical objects, instead of using a screen, keyboard, or mouse (computer components). Belpaeme, Kennedy, Ramachandran [17] also provide a theoretical basis suggesting that the use of these types of robots enables interaction with the physical world, which is the basis for teaching young children. Tangible robots enable the introduction of children into the world of

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STEM, while leading to the learning of basic concepts, such as sequencing, abstract thinking, orientation, decomposition that allow solving the problems that children face.

Authors Randelli, Nardi, Venanzi in [5] emphasize the importance of manipulative robots and include them as the main supporters of learning and creative expression of young children.

It also enables the development of teamwork and collaboration, and children learn basic concepts of behavior and thinking, how to tell a story from start to the end, how to sort numbers starting from the smallest, sort objects by size, shape, and color. An organized environment abounding with new tools such as educational robots fully influences children's socio-emotional development - learning sides, directions, sharing resources and toys, says author Bers [2].

Weinberg and Yu, in their study, stated that robotics creates a unique learning environment by providing physical embodiment of computation; students receive strong, visceral feedback from physically experiencing their work [6]. In robotics classes, as the authors stated, students explore, make hypotheses about how things work, and conduct experiments to validate their beliefs and assumptions. Robots are useful aids for teaching mathematics and physics; they can be used in classrooms for explaining difficult concepts, as they capture the imagination of many younger people [9]. Furthermore, the plug-and-play characteristic of educational robots, like LEGO Mindstorm RCX, makes it easier to learn complex engineering subjects without having prerequisite knowledge. Another study examined the effectiveness of a LEGO robotics course on students' understanding of gear functions and mechanical advantages. The authors of this study concluded that robotic sessions improve students' understanding of gear function in relation to direction of turning, relative speed, and number of revolutions [7]. Martin in [4] applied the "Programmable Brick", a new educational technology that was an extension of

LEGO is suitable for introducing technology to students. The Programmable Brick combined the functionality of the desktop computer and the interface to the LEGO motors and sensors into a single brick. Martin found that the Programmable Bricks expand design and learning possibilities and children effectively learn technology when they are engaged in design, construction, and debugging activities.

### III. THE IMPORTANCE OF TANGIBLE EXERCISES DURING THE PRESCHOOL PERIOD

During the preschool period children learn how to understand the functionality of objects and appearances they encounter constantly, how to remember them without seeing them. In early childhood, children struggle with abstract appearances, so they often rely on physical appearances, objects, and impressions that help them formulate, ask and answer, and understand how the world in which they live works. Although mastering cognitive concepts may seem daunting, children can easily overcome it because they have a special learning tool that helps with the abovementioned things, and that is the play.

Typically, the play involves manipulating with physical objects that surround and encourage learning and allow children to explore and understand abstract concepts in the educational domain. As children play, they enter the physical world using their five senses. Hence, special importance is attached to traditional toys that allow the development of their small hands and fine motor skills, by modeling structures that they see in their daily lives or design and build completely new ideas that arise from themselves.

All this supports the curricula and the study of the provided contents in the form of puzzles, counting cubes, sorting by shape and colour, stacking puzzles and many others.

### IV. TANGIBLE ROBOTS AS A TOOL IN THE LEARNING PROCESS

Encouraged by traditional learning methods, created by Montessori and Froebel, we attach special importance to tangible types of robots, which enable support for the learning process and implementation of curricula using technology on one hand, without exposure to screens, on the other.

Technologies that offer tangible elements encourage socialization and interaction and help children develop self-confidence and their potential. The integration of tangible parts of technology into the learning process based on solving problems, stimulates children's initiative, motivation, perseverance and curiosity as the main drivers of their development [16].

Tangible robots are well-suited to introduce children to the basics of programming in order to develop their skills. With the help of tangible robots and the wooden blocks and cubes they offer, children have the opportunity to connect them by themselves, to create, and in that way to understand the basics of programming [20]. Tangible robots are designed to allow children to engage in the digital and 3D worlds. These robots have components in the form of blocks, directional cubes, movements, built-in sensors, etc. By using them and playing with them and their sensors, young children can become engineers from an early age.

Tangible robots allow interaction through motion sensors and gestures. Using these robots is actually accepting the view

that "Gesture is an innate skill that is adopted in communication", while inserting various sensors that lead to new and interesting interactions between humans and robots, the authors in [5] suggest.

The robots that offer the use of tangible elements and their use and creation of basic programs, enable development of fine motor skills of children as well as development of skills for organization and responsibility. Tangible robots are easily portable and encourage user mobility and development of rough motor skills, which is also crucial for the preschool period and early childhood development.

Through the daily experience of using tangible educational robots with preschool children, we became aware of the fact that learning through play using tangible objects stimulates imaginative thinking and reveals new opportunities for expression and research. The use of hands and manipulative objects changes the way a child learns, acknowledges information, and connects them to everyday situations he or she is constantly confronted with.

The following photographs (Figure 1, Figure 2, Figure 3, Figure 4) are taken in the kindergarten where the first author works. They show the daily activities with the interactive robot Cubetto with tangible blocks. This type of robot encourages the development of fine motor skills, teaches the basics of programming, development of perseverance and curiosity, and the desire to explore.



Figure 1. Sorting of tangible blocks



Figure 2. Presentation of components of tangible robot Cubetto



Figure 3. Perform a step-by-step task with sequencing



Figure 4. Perform multiple steps at once with tangible blocks

#### CONCLUDING REMARKS

Using educational robots in early childhood, which leads to learning and developing computer programming skills in preschool institutions, is a new challenge and innovation for education, especially when it comes to young children. The use of technology in preschool institutions should meet the needs of preschool children and all this should be done through play, in a fun and interesting way and easily acceptable to them. With this, children strengthen their cognitive skills and connect them with new areas they face in their daily lives.

Using robots requires a variety of thinking and problem-solving skills through the creation of various programs. In the initial stage, the most important thing is to motivate children to use robots for new challenges, to encourage the formation of new concepts and solutions, to complement and strengthen the competencies of educators as moderators of the teaching process, and also to introduce the parents as motivators and supporters of child development, through training and coaching in order to understand their importance.

Every child deserves an environment rich in innovative methods and tools that enable and encourage their overall development.

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