Educational Robotics: Teaching Tool In School Education

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Abstract

Educational robotics refers to a field of study that aims to improve student's learning experiences through the creation and implementation of activities, technologies, and artifacts related to robots. Educational Robotics has emerged as an educational approach to support the development of STEM education and the development of 21st-century skills such as critical thinking, creativity, collaboration, computational thinking, coding, algorithmic thinking among learners. Implementation of educational robotics fosters social skills in learners such as team work, discipline and compromise, experimentation. trial and error, enhance self-esteem.It also encourages scientific and technological competencies like computational thinking, scientific attitudes, problem solving ,critical thinking, etc .On the other side educational robotics is not without its challenges like high costs of equipment's, teachers training and professional development in using educational robots for education.

Keywords: Robotics; educational robotics; STEM; School Education

Introduction

Robotics is an interdisciplinary research area at the interface of computer science and engineering. Robotics involves the design, construction, operation, and use of robots. The goal of robotics is to design intelligent machines that can help and assist humans in their day-to-day lives and keep everyone safe. Robotics draws on the achievement of information engineering, computer engineering, mechanical engineering, electronic engineering, and others.

Robotics develops machines that can substitute for humans and replicate human actions. Robots can be used in many situations and for many purposes, but today many are used in dangerous environments (including inspection of radioactive materials, bomb detection, and deactivation), manufacturing processes, or where

humans cannot survive (e.g. in space, underwater, in high heat, and clean up and containment of hazardous materials and radiation).

The term "educational robotics" refers to a field of study that aims to improve student's learning experiences through the creation and implementation of activities, technologies, and artifacts related to robots (Angel-Fernandez and Vincze, 2018). Educational Robotics for learners is a sub discipline of robotics applied to the academic field that focuses on the design, analysis, implementation, and operation of robots. It can be taught at all educational levels, from nursery and primary education to postgraduate studies. Robotics for learners can also encourage and facilitate instruction in other disciplines, such as computer programming, artificial intelligence, or design engineering.

Educational Robotics has emerged as an educational approach to support the development of STEM education and the development of 21st-century skills such as critical thinking, creativity, collaboration, computational thinking, coding, algorithmic thinking among learners. Ministries, policy makers, educators, and stakeholders are always looking for new strategies and teaching methodologies and approaches for developing these skills in students.

'Educational robotics is a field aiming to improve learning experience through pedagogically appropriate methods that make use of robots. It includes the design, application, evaluation, and validation of pedagogical activities in which robots are integrated.' Many schools are coming up with educational robotics to their curriculum, as it brings numerous benefits to students, not only academically but also on a personal and emotional level.

One of the characteristics of robotics for learners is that it is always taught through gamification; that is, it is learned through play. Robotics makes it possible to assimilate mathematical, physical, mechanical, or computer concepts in a fun way and, consequently, improve the acquisition of skills that are part of the school curriculum.

'Educational robotics allows for the exploration, design, modelling, programming, constructing, and testing of unitary knowledge concepts (motion, force, traction…) but also more complex and realistic systems that require a combination of different concepts and methodologies from different disciplines. Educational robotics can support individual and collaborative learning activities and be aligned with different curriculum objectives and competencies' (Unesco Report, 2017). Educational Robotics in schools can help students turn their curiosity and apathy into creativity, innovation, and development of skills. Papadakis & Kalogiannakis (2017) notice that "there are concerns among researchers and education professionals that students in our classrooms are bored, unmotivated and disengaged from school". Eguchi (2012) notices that educational robotics introduce two goals as learning objectives. One goal is to use robots to make children

interested in learning about the world of technology by incorporating classes and activities that focus on teaching children about robots. Another aim is the creation of new projects using robots as learning tools to engage children in activities while teaching concepts not easily taught with traditional approaches.

Eguchi (2017) also notices that learning with educational robotics provides students, who usually are the consumers of technology, with opportunities to stop question and think deeply about technology and that when designing, constructing, programming, and documenting the development of autonomous robots or robotics projects, students not only learn how the technology works, but they also apply the skills and content knowledge learned in school in a meaningful and exciting way. Educational robotics is widely spread at all grades of the primary and secondary education community, and in many cases is adapted as a gamification approach and as a mean of developing Computational Thinking (CT) skills, such as problem representation, abstraction, pattern recognition, decomposition, simulation, verification, and prediction. Although, many doubts and questions have arisen. What computational tools and computational methods are appropriate for the school education settings, how robotics and CT can be embedded in a pedagogical framework integrated with the STEM epistemology, which didactic model should be appropriate for its inclusion (Psycharis & Kotzampasaki, 2019).

Goals of using robotics in educational field

With the application of educational robotics for learners in the classroom, different objectives can be set that influence the development of students at various educational levels.

Educational robotics for learners offers excellent advantages to students in any of the academic stages in which it is worked. This means that it has clear and marked objectives that must be achieved. Some of these objectives are as follows:

1. Develop the critical competencies of the educational curriculum and multiple intelligences.
2. Facilitate a good work environment where good behavior, concentration, respect, and responsibility with the material prevail.
3. Develop natural environments where the student can experiment, thus favoring the meaningful learning of theoretical concepts.
4. Incorporate digital solutions in the interactive activities process, thus integrating the basic concepts of developing the applications used to understand their design.
5. Develop understanding and mastery of the basics of the language of programming.
6. Attend to diversity, since this type of project helps those students who have specific difficulties in some subjects to improve.
7. Increase the active participation of students in their learning process, providing students with tools to achieve their own goals.
8. Develop reasoning, intuitive logic, spatial perception, and fine motor skills.
9. Facilitate the understanding of abstract concepts and gain functionality in learning.

10. Enhance their abilities in problem-solving.

11. Work on the creative thinking, imagination, and motivation of students and promote their autonomy.

12. Implementation of the game as a convenient means of work, fostering creativity and exploration naturally and playfully.

13. Develop new forms of communication and learning that go beyond traditional methods.

14. Learn to work in a group and avoid frustration while promoting cooperation and teamwork.

15. Promote learning by projects, applying educational robotics as a tool to work on content related to science, technology, or mathematics, among others.

Teaching methodology

There is a very close link between educational robotics for learners and the theories of constructivism and active pedagogy. Constructivism is a dynamic process in which the construction of learning is carried out through experiences and not due to the transmission of knowledge.

Therefore, using technological tools in the academic field provides another modality in the learning process, creating experiences for students to build their knowledge. Thus, we can visualize the direct relationship between constructivism and educational robotics.

Benefits of using Educational Robotics

The implementation of educational robotics fosters the following **social skills** in learners:

1. **Team work:** along the process of working in groups learners understand that the results they want to achieve are much more viable if they work together.

2. **Discipline and compromise:** they understand and assimilate the importance of committing to the project they are working on, to be patient and persistent.

3. **Experimentation. Trial and error:** the results of their work become evident very quickly, and they can check by themselves if they are right or wrong. By experimenting, they discover that making mistakes is part of the learning process.

4. **Enhance self-esteem:** while they learn that failure is necessary in every learning process, they develop their capacity for resilience and overcome the fear to make mistakes.

5. **DIY empowering:** they gain autonomy by creating their own robots and solving different problems by themselves, while they learn and have fun.

On the other hand, it encourages the following **scientific and technological competencies**:

6. **Programming language:** they learn their first notions of programming and understand that it must have an order, structure and method.

7. **Computational thinking:** by designing and creating robots they learn how to abstract concepts, divide a big problem into small parts and to propose solutions that can be represented as a sequence of instructions and algorithms.

8. **Scientific attitudes:** they learn and put into practice attitudes such as curiosity, amazement, analysis and investigation. They learn to search, obtain and handle information.

9. **Interest in the technology culture:** they make a first approach to the technology culture, by accessing informatics, internet and multimedia content.

10. **Creativity and innovation:** they can verify there isn't a unique valid solution. This allows them to explode all their creativity, learning from their classmates, and to look for innovative solutions beyond the first possible solution.

Apart from these listed above, there are many advantages and benefits that educational robotics for learners brings to the education and development of children, which is why it is so advisable to introduce it into the school curriculum from an early age:

- It helps them improve their tolerance for frustration.
- They promote the development of logical thinking, scientific intuition, and creativity.
- Develop your research and problem-solving skills.
- Develop your reading and writing skills.
- It makes it easier for the achievement of goals and objectives to become a habit.
- It forms them as subjects capable of thinking for themselves and of appreciating the value of self-motivation.
- Feed their evolution as self-taught.
- It fosters and stimulates skills that will be of enormous importance in their future professionals, such as analytical reasoning, logical reasoning, or critical thinking.
- It stimulates interest in technological sciences, one of the fields with the most significant professional future.
- Robotics for learners encourages logic and reasoning, which is why it is indirectly valid for working on philosophical thinking. It is a process where numerical calculations and logical programming

patterns can enhance the function of analytical thinking through the application of numerical calculations and logical programming patterns.

- Improvement in problem-solving, mathematical operations, and reasoning.

- Robotics is a potentially all-in-one STEM learning experience. Not only do learners step into engineers' shoes as they build and program their robots, they'll build their tech savvy along the way, and even get thinking about how science can solve real-world problems.

Challenges in using educational robotics

A number of challenges have to be met:

- (i) appropriate hardware platforms as well as software frameworks are required,
- (ii) didactic concepts have to be integrated and
- (iii) ways have to be found to share materials and knowledge to allow teachers from different subjects to easily set up courses.
- (iv) Teachers training and professional development
- (v) high cost of implementing educational robotics in school

Conclusion

The incorporation of new technologies in the classroom seeks to improve interdisciplinary learning environments where teachers can develop student creativity and cognitive ability. Robotics for learners brings great benefits to education.

The use of educational robotics for learners in the classroom encourages social skills as well as scientific and technological competencies of 21st century learners, students acquire an active role and build their own learning through this type of active methodologies.

On the flipside educational robotics is not without its challenges. Educators are in fear of instituting robotic and systemic changes that are vulnerable to attacks. They also have to take into consideration costs implications and training of teachers in using educational robots for education. These fears that arise from educational robotics challenges may sometimes be well-grounded. Yet, teachers and schools cannot afford to ignore educational robotics' significance in enhancing learning and process efficiency.

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