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New Developments in Educational Robotics

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Abstract: *Educational robotics is the field of study that focuses on the use of robots to teach and learn. It is a rapidly growing field, with new developments being made all the time. This research article will review some of the latest new developments in educational robotics, including:*

- *New robotic platforms that are more affordable and accessible than ever before*
- *New programming languages and software tools that make it easier for students to learn and create robotics projects*
- *New educational approaches that use robotics to teach a wide range of subjects, from STEM to social studies to the arts*

The article will also discuss the scope for future study in educational robotics, and conclude with some recommendations for how to best implement educational robotics in the classroom.

Among other things, the growing application of robots and artificial intelligence helps to establish a new scientific discipline that seeks to disrupt and revolutionize education. The phrase "educational robotics" is being used to describe a learning aid that is fundamentally altering the education of young people. However, it is also contributing to the development of a rapidly expanding new business that makes instructional tools and robotics. Businesses with a long history of producing and distributing toys or building robotic equipment are establishing the necessary departments and supplying the market with electronic toys for instructional robotics. This emerging market is oversizing and attracting investments very quickly.The market for educational robotics is expected to increase from USD 1.3 billion in 2021 to USD 2.6 billion by 2026, per Markets and Markets research. Specifically, from 2021 to 2026, the educational robots market is projected to expand at a Compound Annual Growth Rate (CAGR) of 16.1%. However, the industry is also drawing a large number of entrepreneurs who are able to secure independent finance for the design and installation of equipment as well as independent efforts that are vying for funding from crowdfunding sites. Through Kickstarter-style sites, more than 2000 concepts have lately received money to be developed and distributed as instructional robotics tools. But what exactly is educational robotics, and how will it change the way that the next generation is taught?

Keywords: Educational robotics, new developments, robot platforms, programming languages, educational approaches, STEM, social studies, arts, scope for study, future directions, recommendations

I. INTRODUCTION

Educational robotics is a rapidly growing field, with new developments being made all the time. Robots are now being used in classrooms all over the world to teach students a wide range of subjects, from STEM to social studies to the arts.

There are a number of benefits to using robots in education. Robots can help to engage students in learning, and can provide them with a hands-on approach to learning science, technology, engineering, and mathematics (STEM) concepts. Robots can also help to develop students' problem-solving skills, critical thinking skills, and creativity.

Although the term "educational robotics" has recently become commonplace, Seymour Papert was the first to design and implement the Turtle robot, which students can move by programming in the Logo programming language. Papert's research and development of tools dates back to 1969. His endeavor is noted as the first attempt at a different approach to teaching programming and algorithmic thinking. On the other hand, Lego, a toy maker, draws influence from it as well. Lego is searching for other options due to its challenging financial circumstances and the expiration of the patent rights on the bricks that serve as the foundation for the creation of its products.The company's new product, dynamic and pro-grammable blocks, is built on the Turtle robot. Lego releases a device that offers customers the ability to program in addition to the more conventional constructing option. Animated units are transforming static constructions

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that aided in the development of several skills. Youngsters learn programming concepts through play, broadening their knowledge base and equipping them with abilities that will probably be essential to meeting the demands of the current world. Meanwhile, a new product is making its way onto the market, and the term "educational robotics" is starting to gain traction in the business world. Many businesses offered comparable solutions in the years that followed, expanding the topic in a multifaceted manner.Businesses like Primo Toys, Hanson Robotics, Robolink, Modular Robotics, and Engino create top-notch resources that revolutionize education. Simultaneously, academic institutions and research centers staffed by scientists from several disciplines (computer science, engineering, psychology, and teaching sciences) are collaborating and introducing instructional strategies that are intended to achieve particular learning objectives. We felt it would be beneficial to create a Special Issue on recent developments in educational robots, given the growing interest from researchers and taking into account the most recent discoveries in the field. The field of educational robotics is concerned with the nexus between education sciences and robots. Regretfully, the lack of journals devoted to this topic in the literature prevents researchers from publishing their findings.As a result, 12 articles total—four of which were review articles—were published in the Special Issue. It is easy to see from reading the essays that five academic institutions from Greece, four from Spain, three from Taiwan, two from Norway, one from Cyprus, one from Ecuador, and one from Chile are included in the Special Issue.(Please see Figure 1) The results from these papers are analyzed in the part that follows.

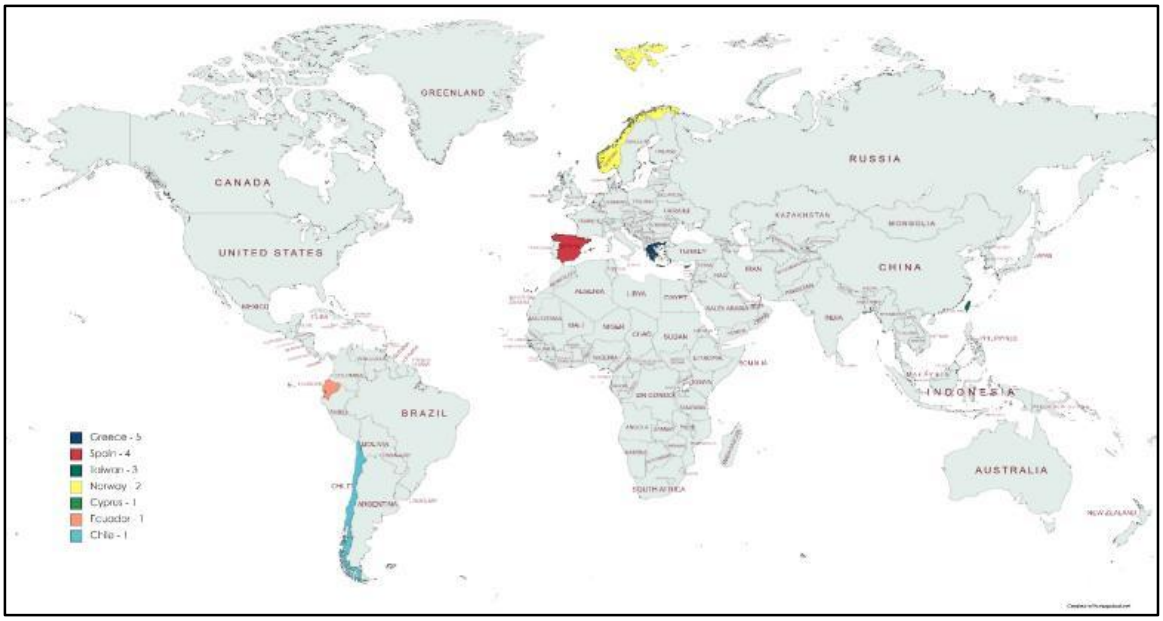

Figure 1. Academic institutions taking part in the Special Issue and their geographical distribution.

The objective of this research article is to provide a comprehensive review of the latest new developments in educational robotics, and to discuss the scope for future study in this field. The article also aims to provide some recommendations for how to best implement educational robotics in the classroom.

Analysis of the Articles:

In their work, Toma et al. created a virtual unmanned aerial vehicle control training system. It visualizes unmanned aerial vehicle behavior using mathematical kinematics and dynamics models. It is possible to use the new technology for teaching purposes without having to buy a physical robot. Additionally, by applying the sophisticated control algorithm for autonomous trajectory tracking tasks in both the virtual training system and the hexacopter experiment, researchers demonstrated the stability and resilience of the controller.

In a different study, researchers present FOSSBot, a novel teaching tool that may be used by students of all ages and programming proficiency levels to address a variety of learning goals. The suggested robot may be printed using 3D technology and has an adaptable software stack that allows for four different operating modes, including text-based and block-based programming. An extensive list of printed and electronic parts, together with assembly instructions, are

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included in the paper. FOSSBot is a special tool for educators that can teach a variety of disciplines at all educational levels, including programming, the sciences, and the arts,this is because of its open nature.

The work of Kassawat et al. also presents a new robotic platform appropriate for cooperative robotics research and education. Using the new robot platform, the researchers provide a brand-new idea for collaboratively lifting, adjusting, and moving an object. Multi-robot object manipulation is made possible by the suggested robot, which has three omnidirectional wheels and two extra traction wheels. Three trials were carried out by researchers utilizing a setup consisting of a single robot and a single target object to validate the new technology.

In her most recent work, Cano created a methodical approach for teaching STEM skills with a genre focus using the Arduino platform. A learning strategy known as 5E (Engage, Explore, Explain, Elaborate, and Evaluate) is a part of the suggested approach. Its goal was to create a series of workshops that would introduce students to programming and electronics topics. Teachers from Latin American schools participated in virtual seminars delivered by researchers using the Zoom platform. It has been established that the Arduino, its parts, and the workshop boost students' motivation, inventiveness, and positive outlook.

A project on instructional robots that was created especially for college students is presented by El-Fakdi et al. in. Using inexpensive materials, participants can construct an underwater device based on the suggested project. The underwater robotics research conducted at the University of Girona is explained by the Underwater Robotics Workshop project, which has been going on for more than 13 years. The project's goals were to advance robotics, electronics, programming, physics, and engineering. Concerned with student satisfaction and learning objectives, the writers included favorable input from participating teachers and students.

The desire for inexpensive alternatives has led to the proposal of yet another educational system in. The HYDRA technique is a suggested approach that targets educational needs in elementary and secondary education. For students who have never programmed or worked with robotics before, the new system offers an extendable, low-complexity modular design. Its slight learning curve, however, is its most significant attribute. Using flow theory, the researchers assessed HYDRA in three distinct Greek primary school classes and discovered a high participant adoption rate.

A distinct use of instructional robots is showcased in the work of Ziouzios et al. More specifically, the researchers used the suggested instructional scenario to gauge how much children's empathy was developing. In this project, a robot delivers a message from the future to the kids, alerting them to the dangers of climate change and urging them to adopt new perspectives. Teachers' prior knowledge enhanced and supplemented children's developing empathy and the efficacy of programming the robot, according to a pilot study involving fifty sixth-grade students. Furthermore, students' attention and participation were raised by the use of a robot to deliver the lesson.

Regarding humanoid robots, a multidisciplinary framework for their use in educational settings was presented by Mishra et al. The four components of the suggested framework are technological, educational, the effectiveness of humanoid robots, and an ethical analysis of the use of these machines. The authors also included a case study and an application and evaluation method for the framework. In order to study their interactive designs of oral tasks, Lin et al. Carried out a systematic review of 22 empirical studies published between 2010 and 2020. They assessed the teaching strategies, the kinds of oral tasks, the role played by the robots and facilitators, and the efficacy of the designs as a tool for enhancing oral competency.Researchers came to the conclusion that the most common language learning strategies used in robot-assisted language learning instructional design are communicative language teaching and storytelling, which are frequently supplemented by audiolingual and total physical response techniques.

Papacostas et al. provide a systematic review covering the usage of humanoid robots in special education from 2008 to 2020. The study examined the extent to which social robots are incorporated into the training of special education individuals, evaluated the applicability of social robots for various impairments, looked for various social robot types and their suitability for various impairment categories, and identified issues that must be resolved before social robots can significantly aid in the social integration of individuals with disabilities.The evaluation featured a range of robots designed to target youngsters with diverse special education needs and skills. It is noted, although, that the majority of them were not created with the unique requirements of special education students in mind.

In their review, Sophokleous et al. concentrated on the research demonstrating the ways in which computer vision aids in instructional robotics. Through a methodical mapping procedure, they examined 21 main works from the current body of literature. More specifically, they looked into the function, advantages, and effectiveness of computer vision in

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educational robots for K–12 learning. The study demonstrated the great potential for computer vision to support instruction in educational robots. It has also been demonstrated that the employment of computer vision in instructional robotics projects raises students' attention and satisfaction levels. In addition, they finish their job faster and retain the material provided to them more effectively.

Lastly, Belmonte et al. examined 926 scholarly publications from the Web of Science database that addressed the idea of "robotics" in the context of education. The writers covered a wide range of subjects, including applications, engineering, inter-disciplinary computer science, scientific discipline teaching, and educational research. The majority of the examined papers were included in conference proceedings. This work identified three distinct periods based on the focus of the scientific publication: from 1975 to 2012, the most important subjects were "programming" and "computational thinking"; from 2013 to 2016, the most important topics were robot physics engineering issues, and fundamental concepts of education; and from 2017 to 2019, the most discussed topics were technologies supporting training and simulation techniques.

II. REVIEW OF LITERATURE

A number of recent studies have shown the benefits of using robots in education. For example, one study found that students who were taught using robots performed significantly better on math and science tests than students who were taught without robots. Another study found that students who participated in robotics programs were more likely to pursue STEM careers.

In addition to the benefits listed above, educational robotics can also help to:

Improve student motivation and engagement

Promote collaborative learning

Develop students' communication skills

Increase students' self-confidence

Scope for Study:

There is a great deal of scope for future study in educational robotics. Some specific areas of interest include:

- Developing new robotic platforms that are even more affordable and accessible
- Creating new programming languages and software tools that make it even easier for students to learn and create robotics projects
- Developing new educational approaches that use robots to teach a wider range of subjects in more effective ways
- Conducting research on the long-term impact of educational robotics on student learning and achievement

III. CONCLUSION

Educational robotics is a rapidly growing field with the potential to revolutionize the way we teach and learn. New developments are being made all the time, and there is a great deal of scope for future study in this area.

On the other hand, instructional robotics is a potent and adaptable learning instrument that helps teachers and students in a variety of learning settings. The main applications of educational robots are in the fields of science, math, technology, and computing education. But it can also be used in other domains, like the arts, theater, and literature. The robot can be used to provide engaging and useful activities as an educational tool. It contributes to the fun, interactive atmosphere that keeps kids interested and involved. Additionally, a key component of positive motivation is the play component of robotics. Students become active participants in the learning process and stop being passive consumers of knowledge through practical robotics exercises. They are able to "master" and gain deeper understanding of their study subjects thanks to the exercises.Research has demonstrated that engaging with robotics not only imparts new knowledge but also fosters the development and enhancement of 21st-century abilities including problem-solving, critical thinking, and teamwork.

Recommendations:

Here are some recommendations for how to best implement educational robotics in the classroom:

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Start with a well-defined learning objective. What specific concepts or skills do you want your students to learn?
Choose a robotic platform and programming language that is appropriate for your students' age and skill level.
Provide students with clear instructions and support.
Encourage students to be creative and to experiment.
Make sure that students have opportunities to collaborate with each other and to share their work.
Assess student learning regularly.
By following these recommendations, you can ensure that your students have a positive and productive learning experience with educational robotics.

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