Robotics in Education

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ABSTRACT

Robotics is the discipline of creating robots. It is a branch of engineering that involves the conception, design, manufacture, and operation of robots. Robotics in education is a growing field where robots teach students subjects. Robots play different roles in education. These include teaching assistants, personal tutors, small group leaders, and peer learners. Robots can teach people of all ages. To prepare students adequately for the challenges of an increasingly digital world, an early education on robotics is compulsory at all levels. This paper explores the uses of robots in the education industry.

KEYWORDS: *robots, robotics, education, robotics in education*

INTRODUCTION

Education has always been a controversial subject. In a traditional learning environment, a teacher writes on the black board everything she knows to a group of students that records the information. New classroom approaches, methods, and techniques are continually discussed, developed, implemented, and then replaced with newer, more effective ones. Access to the Internet, overhead projectors, interactive boards, comprehensive online databases, and animation software are just some of the technologies that teachers have been constantly using over the past decades. The introduction of Information and Communication Technologies (ICT) in education has completely transformed the teaching-learning process and reshaped knowledge acquisition [1].

In today's technology-driven world, it is important to prepare the students of today for the future. It is important for the schools to provide robotics education to their students to ensure that the student are well equipped with skills necessary for a bright career and future. Robotics, an offshoot of artificial intelligence, is the new kid on the block to captivate the imagination of the young generation all for the right reasons. Robots are being used in a variety of areas such as manufacturing, healthcare, entertainment, military and defense, service industries, design, construction, law enforcement, education, shopping, and agriculture. Today, there are robots that can autonomously sense, reason, plan, act, move, communicate, and collaborate with other robots. The robot revolution is going to change us as humans [2].

WHAT ARE ROBOTS?

The word "robot" was coined by Czechriter Karel Čapek in his play in 1920. Isaac Asimov coined the term "robotics" in 1942 and came up with three rules to guide the behavior of robots [3]:

1. Robots must never harm human beings,
2. Robots must follow instructions from humans without violating rule 1,
3. Robots must protect themselves without violating the other rules.

Robotics has advanced and taken many forms including fixed robots, collaborative robots, mobile robots, industrial robots, medical robots, police robots, military robots, officer robots, service robots, space robots, social robots, personal robots, and rehabilitation robots [4,5]. Robots are becoming increasingly prevalent in almost every industry, from healthcare to manufacturing. Figure 1 indicates that robotics is one of the branches of artificial intelligence.

Robots include articulated robots, mobile robots or autonomous vehicles. Other forms of robots in common use include drones and chatbots. Drones are flying robots, a type of robots, that are poised to proliferate in certain commercial sectors. Drones can help utility crews after a storm by quickly and safely identifying areas in need of repair. Drones can also help with maintenance tasks, such as surveying solar panels for damage.

Chatbots have empowered the banks and other financial institutions by simplifying the complex processes. We interact with Facebook Messenger bots all the time. Messenger bots are revolutionizing the small business world. Messenger bots can answer customers' questions, collect user's info, organize meetings, reduce overhead costs, and engage in other business tasks. Big companies like Walmart, Alibaba, and Amazon have been benefitting the help of bots.

EDUCATIONAL ROBOTICS

There are many robots available with some keys to promoting robotics learning in the classroom. These are known as educational robots. Educational robots (also known as pedagogical robots) teaches the design, analysis, application and operation of robots. Educational robotics can be taught from elementary school to graduate programs. They are used to allow students to pick up skills in a range of Science, Technology, Engineering, and Mathematics (STEM) disciplines. Such skills are increasingly important in a world in which technology is advancing rapidly. The goal of STEM education is to help students organize information within and across disciplines. Science is the explanation of the natural world. Students that are scientifically literate are able to understand both the concepts and practices of science. While science describes the actions of our world, whereas engineering involves finding solutions to a particular problem.

Educational robotics is considered as a means of forming the engineering thinking and creativity in schoolchildren. Educational robots enable students of all ages to become familiar with and deepen their knowledge of robotics and programming. The robots facilitate learning and introduce students to robotics

at a young age. As students grow older, more advanced robots can be used that can perform more complex tasks and are more complicated to program. Examples of educational robots are in Figure 2 [6]. Educational Robotics can be an effective tool to teach computational thinking while also helping to broaden participation goals. It has flourished as teachers and schools embrace the potential of robotics to provide hands-on and engaging ways to teach design.

Educational robots often come equipped with eyes, mouths, and other facial features that can read emotions. Many companies now provide robotic building kits that educators can use to build systems thinking, learn engineering, and practice STEM concepts. Educational robots can they help young students develop cognitive skills and mathematical thinking at an early age. They also give them skills that they can transfer to other areas of their learning.

Other benefits of educational robots include [7].
- Preparing students for future career opportunities
- Helping remote students access their school
- Help the students to develop teamwork and co-operative skills
- Increases Creative and innovative skills of students
- Help the students to communicate and learn different advanced technological platforms
- Simplify complex programming from a young age
- Support students with special needs
- Promote the development of cognitive skills among children and young people
- Stimulate imagination and creativity
- Help students deepen their knowledge of robotics and programming
- Make STEM simple and fun to learn

APPLICATIONS

There is a place for lessons involving robots in every grade and every subject. Teachers who want to incorporate science, technology, engineering, and math (STEM) as well as computer science (CS) into their curriculum can consider robotics. They should keep things simple and focus on fun and the intended learning. There are many potential applications for robots. Some of these application areas in education are presented as follows [8]:

- *Elementary School Education*: Robots can be used in early education since they are very popular with children. Increasing robotic literacy is therefore crucial in the early stages of education. Therefore, K-12 educators can turn to robotics as a way to get students excited about science, technology, engineering, arts, and math (STEM) education. Robots can be used to bring

students into the classroom that otherwise might not be able to attend due to their health condition. Robots can "bring school" to students who cannot be present physically. A teacher must identify the specific learning objective they want the robot to help you to achieve, and then use the robot accordingly. Children are generally curious and love to experiment with hands-on activities. Figure 3 shows how robots help children develop skills [6]. Robots can be useful for teaching language to children, while children can enjoy learning the language with a robot,

➢ *Higher Education:* Robotics is a growing field that has the potential to significantly impact the nature of engineering and science education at all levels. For example, when receiving a medical education, the use of robotics is beneficial. When learning to perform complicated medical procedures, a human subject is not feasible. Medical educators are employ the use of robots as stand-ins. Robots can be created and programmed to give off all indications of human life, including breath and heartbeat. In addition to providing medical students with the means for thorough exploration of the human body, simulators can provide exceptional methods of crisis and disaster training for emergency response.

➢ *Personalized Education:* Personalized learning aims at supporting learning in which the learning environment is a crucial factor. Shortage of teachers has put pressure on educators to serve more students, but robots are easing some of the strain. The ability of robots to talk with children makes them ideal for personalized education roles. Robots have exhibited enough autonomy to the point where they can interact with kids in one-on-one basis. A robot can act as a tutor, giving students the individual attention. A single teacher does not have the capability to meet the needs of personalized learning for every student. A robot does not replace the teacher but allows students to learn at their own pace.

➢ *Special Education:* The appeal of robots lies in the way they can adjust to a child's learning abilities. This is important when it comes to teaching autistic children. Autism is characterized by people typically finding challenges with understanding social communication and social interaction. Students with special requirements can be reached through the use of robotics in the classroom. Assistive technology is growing, and the abilities it provides to special education students are limitless.

➢ *Coding:* Even if students have no interest in a coding career, teachers can introduce coding into their curriculum easily through various programs. Educational robots are excellent for teaching kids fundamental engineering design and programming skills. They allow students to see and interpret code results in real time. Dash and Dot Robots are popular for the programmable personality features of the bots, which are a big hit with elementary-aged learners. They are both kid-friendly programming teaching tools and interpreter of the "programmable" units. Dash captivates children with singing and dancing while exhibiting the ability to respond to voices. Studies indicate that gender, interest, and prior experience with robots influence the level of motivation to learn more about coding.

➢ *Competition:* Robotics competitions are events where participants are required to design and produce robots and compete with each other. A competition for students presents a central problem and asks participants to develop a solution. Students can participate in robotics competitions across the whole world. Robotics competitions improve students' problem-solving skills. They help students of all ages see what they learn in practice. They also provide a great way to teach coding and gain universal skills. Figure 4 shows a design for competition [9]. Competition creates infectious excitement on their faces of participants, especially the winners.

In addition to these applications, robots can be used in learning languages and learning environment,

BENEFITS

Robotics is an entertaining and innovative pedagogical tool that is becoming very important in the modern society. It has seen an exponential growth in the past decade. In addition to being fun, robotics includes the fundamental concepts of STEM that gives an excellent platform for students to enjoy learning. Not only can robots optimize the learning experience, they can also give students the key computer skills required in the job market. There are endless educational possibilities with robotics. Robotics offers great opportunities for teamwork and collaboration. It encourages children to learn valuable life and career skills

Due to the incredible potential of robotic technology, application opportunities are limitless in the future. Current trends lead many people to believe they will take over the workforce in many sectors and there will be increase in demand for automation [10].The robotics revolution is inevitable. It is rapidly accelerating, as technology advances in automation,

engineering, energy storage, and artificial intelligence converge.

CHALLENGES

Providing each student with actual robots may be expensive for the school. To create diversity within robotics education, there must be an acknowledgment of gender imbalances. Many companies are now paying close attention to how their robotic devices are perceived and are trying to develop gender-neutral solutions. Companies that offer educational robotics products are putting extra effort towards engaging girls and other underrepresented populations.

CONCLUSION

Robotics is a field at the crossroads of computer science, technology, and engineering. STEM and robotics will soon become inseparable components of one another. Robotics is one of the most necessary aspects of education today because children will interact with or encounter robots their entire lives. As robots replace a growing number of workers, there will be plenty of career opportunities for those who know how to design, develop, and program them. Integrating robotics into the curriculum exposes students to practical skills that could lead to a promising career. Robots could prove a huge boon to education.

Robotics education should be compulsory since robotics is closely intertwined in our lives. Students need to learn the fundamental basic of robot programming and operation. Students can become the architects of a better future by integrating robotics into the curriculum through carefully designed courses. They can learn about robots through courses, STEM robotics camp, online programs, robotics competition, robotics kits, and by joining robotics groups.

Robotics is an integral part of cutting-edge careers like aerospace engineering, computer science, and hardware design. The skills in robotics is highly sought after in business and other sectors. If you aspire to be a roboticist, you will need some key skills, such as mathematics, and science. For more information about robotics in education, one should consult the books in [11-19] and the following related journals devoted to robotics:

➢ Robotica
➢ Robitics and Autonomous
➢ Robotics and Computer-Integrated Manufacturing,
➢ Advanced Robotics
➢ Autonomous Robots
➢ Journal of Robotics
➢ Journal of Robotic Systems
➢ Journal of Robotic Surgery
➢ Journal of Robotics and Mechatronics
➢ Journal of Intelligent & Robotic Systems
➢ Journal of Mechanisms and Robotics-Transactions of the ASME
➢ Journal of Automation, Mobile Robotics and Intelligent Systems
➢ Journal of Future Robot Life
➢ IEEE Robotics and Automation Letters
➢ IEEE Transactions on Robotics
➢ International Journal of Medical Robotics and Computer Assisted Surgery
➢ International Journal of Robotics Research
➢ International Journal of Social Robotics
➢ International Journal of Humanoid Robotics
➢ International Journal of Advanced Robotic Systems

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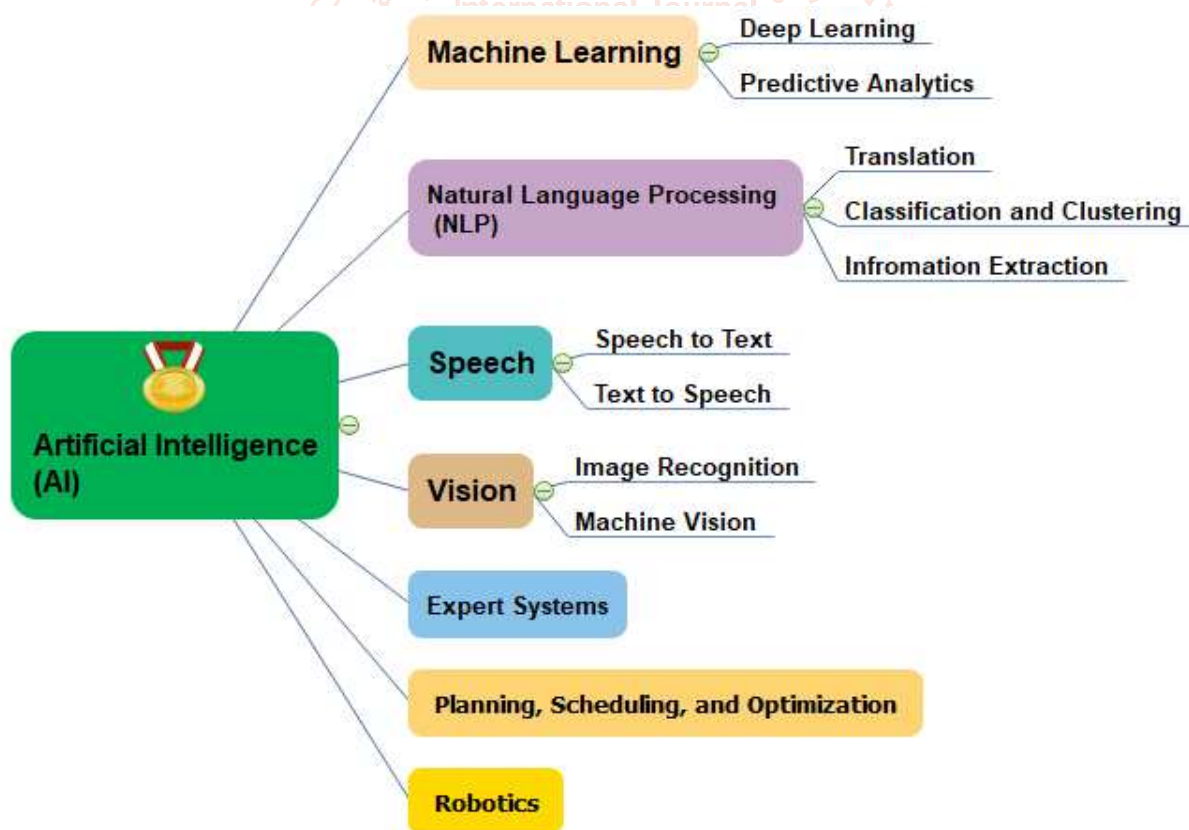[14] B. Siciliano and O. Khatib (eds.), *Springer Handbook of Robotics.* Berlin: Springer.

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Figure 1 Robotics is one of the branches of artificial intelligence.

Figure 2 Examples of educational robots [6].

Figure 3 How robots help children develop skills [6].

Figure 4 A design for robotics competition [9].