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Role of Robotics Technology in the Field of Education

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***Abstract*— At present when Covid 19 has influenced the whole world and led to people restricting themselves at home only. Every sector is harmed during this pandemic time, especially education. Hence, the application of robots in education may be a remarkable step in fostering education and can be benefited in pandemic times when the education system collapsed. The education sector is still operating traditionally and hence needed the improvement of the present status of education using the latest technology such as robotics. Robotics in education refers to the function that can perform by robots in the classroom similar to teachers. In this review paper, we have gone through a deep study of more than 50 papers to understand at what level robotics is implemented in education with its typical application and to find out the further scope of work. As such, there is no single paper available in the literature that addresses all concerns of robots in education in detail. The proposed study on educational robots is classified under learning activity, impact on curriculum, integration of the robotic tool, and evaluation of activities. This work will help other researchers in identifying the existing research gap in the field. The rigorous review has been presented well in a graphical and tabular manner for clear understanding.**

Keywords— Educational robotics, autonomous robotics, assistive robots, growing, ICT, STEM, formal, non- formal, quantitative, evaluating, interaction

I. INTRODUCTION

A robot is any autonomously driven mechanism that replaces human effort whether or not it looks like a human or performs human-like duties. The term robotics comes from the Latin word robot which means work and it is used in a variety of fields such as medical, industry, and education. Robotics technology has become increasingly integrated into human lives to make living easier. By deploying a modern, cost-effective robot, there are several alternatives for introducing educational robotics into the teaching-learning process in science, technology, engineering, and mathematics (STEM) education [1]. Robotics in education and educational robotics. In education, robotics is a broad term that refers to the functions that robotics can do in the classroom. for example, assist disabled students in overcoming limits or teachers in gaining attention or delivering content to students. Educational robotics encompasses a wide range of fields, including robotics, pedagogy, and psychology. The impact of the learning environment on the student's school curriculum. Fig. 1 depicts Robots in Education, with educational robots being a subset of robotics in education. Students can study in a variety of circumstances when it comes to learning environments (e.g.at school, at home, in an outdoor environment). The physical location learning context and cultures all contribute to the uniqueness of each setting. Whether the learning environment is formal or informal each set usually has its own set of norms and ethos that determine interactions, behaviors, and learning activities. How activities are integrated with education has a significant impact on their design and desired consequences. Curricular activities are activities that are carefully designed to meet curriculum needs and carried out consistently in the classroom to improve students understanding of ideas and whose evaluation is recognized in the school's final student evaluation [2].

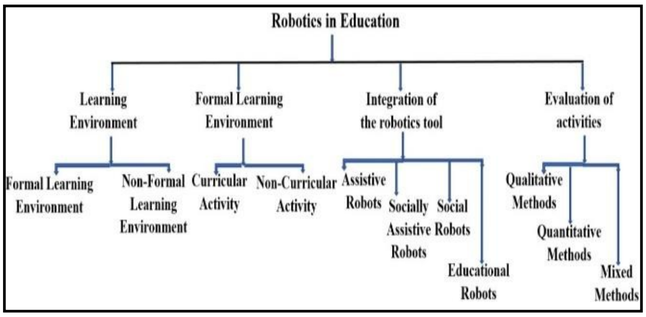

Fig. 1 classification of robots in education [2]

The modern educational landscape is defined by ubiquitous access to information and collaborative and technological learning methodologies. The backbone of the evolution of the educational sector is the technical resources employed in the technical-learning process. Robotics education is a technical trend that is gaining popularity in a variety of fields thanks to its potential to develop programming abilities and computational thinking both of which are crucial nowadays. The use of robots and programming in the classroom allows students to build meaningful learning through cooperation and teamwork. Educating students with information and communication technology (ICT) resources and programmable educational robots. Programmable educational robots are helpful in skills development and created essay way to imagination and practical in complex topics in STEM curriculum in learning for children and students [3]. Educational robots are a type of educational technology that aids students in learning and improving their grades. Robots provide embodiment and the ability to include social interaction into the learning environment, allowing students to progress beyond software-based learning. Informal educational robotics activities are designed to engage youngsters in a ludic introduction to robotics without assessing their learning performance. Despite the lack of Leary defined learning objectives or assessments, children have the opportunity to learn about programable robots or automatons in an informal setting. Fig. 2 shows the teamwork and collaborative learning of children through robots [4].

Fig. 2 educational robotics activity in the library [4]

In a research field, educational robotics involves students in the use of robotic technologies to achieve one or more learning objectives or skills. The educational robot is situated at the intersection of psychology, artificial intelligence, and educational research. Robotics activities for children strive to complete an activity in the library and evaluate their learning performance [5].

APPLICATION OF EDUCATIONAL ROBOT

New pedagogical approaches boost students' knowledge and interest which is not available in the teaching- learning process. During a covid pandemic, pupils are merely passive recipients of the teacher's theoretical explanations. Educational robots can be valuable in the classroom from this perspective [6]. Based on best pedagogical practice and educational research, educational robots will aid in the design and promotion of open educational and technical goods and practices for both formal and informal learning situations. Encourage academics, instructors, and students to communicate and collaborate by establishing. To support teacher education by assisting in the establishment and running of schools for teachers. Educational robotics should be viewed as a tool for cultivating crucial life skills like imagination, self-expression, and the ability to make distinctive and valuable judgments [7]. The application of this is given as follows:

- Educational robots have a lot of potential as teaching tools. The ability to do repetitive tasks correctly, the ability to show digital material interactivity, and the possibility to present a humanoid look including body movement are all characteristics of an educational robot.
- Educational robots enable educators to provide a variety of models for a wider range of educational applications, for example, the robots can typically be used to provide learners with interesting activities and hands-on experiences resulting in a more engaging, attractive, and dynamic learning environment.
- In the task, in communication with proper explanation and suitable dynamic learning environment. Educational robots are a useful tool for raising student motivation and performance.
- Robots give measure contribution to the skills development of students in 21st-century with the aid of educational robots. In addition to enhancing, student learning performance is increased, educational robots are a powerful learning instrument in the learning skills development of the 21st century.
- Educational robots can be used in STEM education as a team-based design project that encourages communication and cooperation among students. The needs of our educational system can be met by educational robots and they can also assist us in establishing a new standard of education for the twenty-first century [8].

II. CONTRIBUTION OF ROBOTICS TO EDUCATION

Robots' role in education includes helps in foster learning and creativity through formal and informal learning environments, curriculum effects, and activity evaluation.

Learning Environment

The learning environment is two major parts formal and informal. Formal learning is that which takes place as intended with formally constituted educational institutions such as schools, colleges universities, training centers, and so on. Typically it follows a prescribed framework whether or not actual attendance at the institution is necessary. Informal learning refers to learning that occurs away from a structured, formal class environment. Informal learning comes in many forms, including viewing videos, self-study, reading articles, participating in forums and chat rooms, performance support, coaching sessions, and games [2]. Tengler et. al [9] have explained that problem-based learning is the most frequent learning technique at the elementary school level, especially when conducted with the aid of technological resources for a successful learning process. Eshach [10] has presented his research on non-formal learning that occurs in institutions and organizations in a planned but highly adaptive manner. Lanz et. al [11] have proposed research on concrete problem statements, multidisciplinary challenges, and equipment that enhances active learning. This learning environment and concept intend to improve learning skills and critical thinking, employability skills, information technology and digital skills, innovation, and interaction and communication skills, under the academic board's goals. Burleson et. al [12] have explained the physical and virtual programming tools employed in his project which was inspired by constructionism a learning philosophy in which a student obtains knowledge by making something. Papert [13] has explained the development of the first physical robotics system for teaching arithmetic in the early 1980s. The robots in this framework were controlled by children using LOGO commands such as advancing 50 to move the robot ahead fifty steps. These robots provided a tangible learning benefit to children and students. Jou et. al [14] have described the use of robots for meaningful learning experiences everywhere due to the advancement of internet technologies. Through the internet real robots can be controlled remotely. A web-based simulation of the robot in action was created. The simulation is the mode in javascript and used a freeware gaming library to control robots and environmental objects.

Impact on Curriculum

Activities that are meticulously planned to achieve the curriculum objectives and implemented regularly in the classroom to aid students' knowledge of subjects. Non-curricular activities are designed to aid in the teaching of specific topics both within and outside of the classroom but they do not result in any formal recognition. Curricular activity on the other hand is an activity that takes place outside of the classroom and is recognized by the school in the student's final evaluation [2]. Kolberg et. al [15] have presented work on the integration of technology in the lower class of education using a mobile robot as the primary tool of the curriculum one possible strategy for integrating technology in 5th and 6th grades are to create a knowledge of technology as part of science and to provide an insight into the engineering profession. Kopcha et. al [16] have presented work on robots used in the STEM education system. Robots are used to promote students' computational thinking in an integrative standards-based STEM program. In K- 12 STEM education it connects STEM to the real world which makes the topic more relevant to students and instructors. Because several factors are driving the need for improved STEM education. Many companies are looking for people who have STEM skills and thinking, such as creativity, innovation, critical thinking, problem-solving, information literacy, and media literacy. As technology progresses and becomes more widely available the demand for students to engage in STEM ideas and abilities is expected to rise. Because it teaches students complex mathematical and scientific reasoning robotics is regarded as a vital part of STEM education. In STEM and curriculum activities robots play important role in the development of a student. Parola et. al [17] have examined that proposed a robotics course in autonomous driving/self-driving to a lower secondary school third-year class to ensure that all curricular activities were covered, with the competence goals and learning targets in science, technology, and mathematics defined in the national recommendations for the school curriculum.

Integration of the robotics Tool

The robotics tools used in the activities should be categorized based on the educational purpose they provide. Students with physical disabilities may benefit from assistive robots. Most of these tools are medical ones that support people with their regular activities. Some robots can assist people with social disabilities. This category of robots is known as socially assistive robots. Some robots can accompany pupils as they learn or teachers as they educate. These are known as social robots. Educational robots can be used to learn about robotics and STEM subjects while also developing cross-disciplinary skills [2]. Freddi et. al [18] have evaluated assistive technology is becoming more limited. Traditional wheelchairs are one of the most prevalent types of assistive equipment and they were one of the first answers to the mobility problem for individuals with disabilities. Smart electric wheelchairs with integrated sensors and computing capabilities are currently being developed. Feil-Seifer et. al [19] have demonstrated socially assistive robots to support a wide spectrum of people. Those students with physical disabilities people in convalescent care and people with cognitive disorders. Belpaeme et. al [20] have explained the robots with various responsibilities for social robots for teaching. The educational robots can enhance learning by communicating with voice-based technology which help is more needed for a disabled person. Fig. 3 shows an example of social robots where children are taught to play chess by the iCat robot, A child's penmanship is improved with the help of Nao robots, a Keepon robot is coaching an adult, and the Pepper robot gives motivational English education.

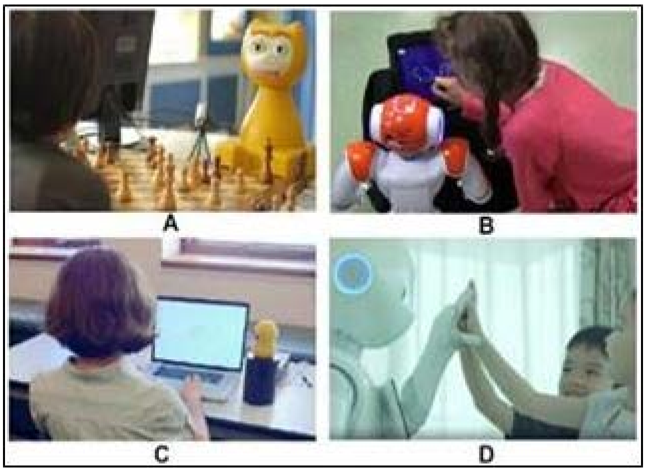

Fig. 3 shows examples of social robots for learning [20]

Denis et. al [21] have focused on the six teaching and learning paradigms concept that can be used to describe and analyze educational robotics activities. These paradigms suggest quite diverse types of interactions between trainers and learners, as well as various proportions of learner and trainer initiative.

Fig. 4 shows six learning/teaching paradigms of creation, experimentation, exploration, practice, reception, and imitation presented. The learner learns specific competencies according to the paradigm. In learning/teaching paradigms creation, when the general design is determined by the trainer or another learner, the construction and programming of the robot are the sources of originality, not the project selection.

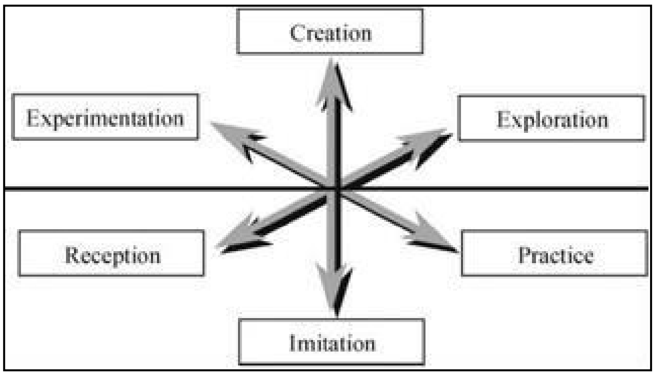

Fig. 4 six learning/teaching paradigms [21]

In exploration, learners can achieve this by looking over certain didactic materials. In experimentation, the ability to create unique robots is largely dependent on the flexibility of the material. In imitation and reception, the students could also use salvaged waste items or materials to make their robot or automaton from their imagination. Gonzalez et. al [22] have created an educational robot that enables the creation building and growth of learning environments in which participants can get proper knowledge. In this activity, the participant is the primary actor in the construction of knowledge about the topic or phenomenon under investigation. This activity plays an important role in concepts increasing the student's systemic, logical, structured, and formal thinking according to robotics-based learning environments.

III. Evaluation of Activities

Robotics in education activities could be evaluated using a qualitative, quantitative, or mixed-method approach. In education, the qualitative method applies to both research and everyday practice. Quantitative methods give the best part of the quantitative and mixed methods. Mixed-methods research has been proposed as an appropriate research method for addressing problems in complex environments [2]. Dautenhahn [23] has focused on simple interaction skills robots which are employed in autism therapy as a teaching device. An autonomous robotics platform in a remedial tool for children with autism is what aurora stands for. In the aurora project, robot-human interactions are often unregulated and unstructured children are allowed to explore and discover their interaction talents rather than being officially taught. The children are allowed to engage with the robot in any posture they desire (e.g., lying on the floor, crawling, standing) and in any way, they wish during these sessions (touching, approaching, looking from a distance, picking it up, etc.). These settings are substantially different from those of earlier programmers in the area of robot-human interactions. Caleb-Solly et. Al [24] have research to investigate the needs of senior citizens for a household robot. The household robots can move, stare and speak in human-like ways. This is referred to as proxemics, and it is based on a framework of social-spatial zones of human interaction. Fig. 5 is a ROBOSOFT's mobile robot used for guiding senior citizens

ADVANTAGES OF EDUCATIONAL ROBOT

The advantages of an educational robot are given as follows

- Students' knowledge representation and construction through the creation of large projects based on real-world paradigms.
- In both the virtual and physical worlds, learning by doing fosters a secure problem-solving environment.
- By assisting students in representing their information, they can learn by reflection.

Fig. 5 ROBOSOFT mobile robot for interaction [24]

- Collaboration, discussion, and reasoning are all ways to learn via conversing.
- Flexibility, digitalization, repeatability, humanization, and natural interactivity are all qualities of educational robots.
- Robotics technology is a fascinating topic that is gaining traction. For students in the area, there are numerous advantages. It has the potential to open up a world of possibilities for those who are interested.

Educational Robotics play an important role in the Transformation of the world

• Medicine, aged care, rehabilitation, education, household appliances, search and rescue, and the automobile industry have all used robotics technology.

• Educational robots alter our educational system by changing the teaching technique and developing new teaching and learning methodologies.

Robots help to increase our economy and develop the most efficient methods for dealing with complex tasks in the educational system. Robot's labor work Schools, colleges, and other educational institutions are open seven days a week, 24 hours a day.

Robotics for education Participation brings pleasure

• A more flexible experiential curriculum that can accommodate a cross-thematic and constructivist approach as a teaching tool is required for educational robots.

• After competing in a robotics competition, students' ideas on the social value of science are altered. shifted, with students adopting a positive attitude toward science and technology.

• Children who participated in a robotics competition had higher self-confidence and problem-solving ability.

• According to studies technological innovation and educational robots in the educational system are intrinsically linked to young people who are fascinated by their advancement. As a result, new ways of instruction are required. It is necessary to develop strategies that take advantage of children's familiarity with technology.

IV. RESULT AND DISCUSSION

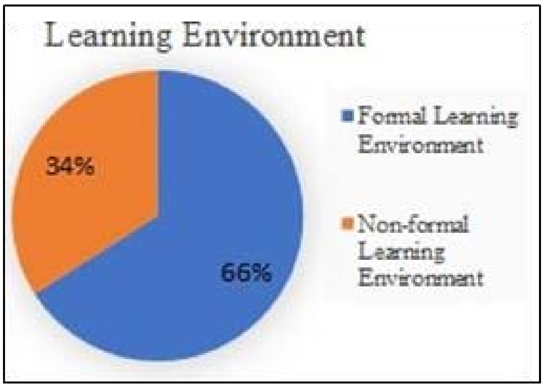

Fig. 6 work is a learning environment in formal and non-formal learning environments

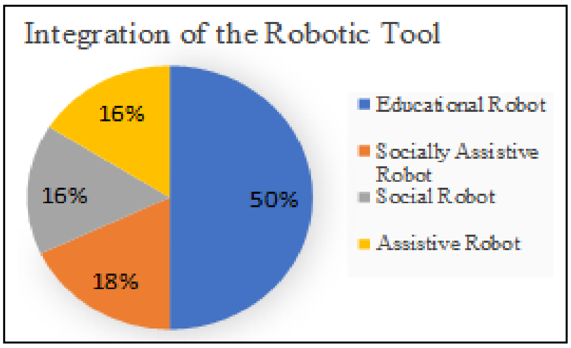

Fig. 7 works on the impact on curriculum in Curricular and Non-curricular

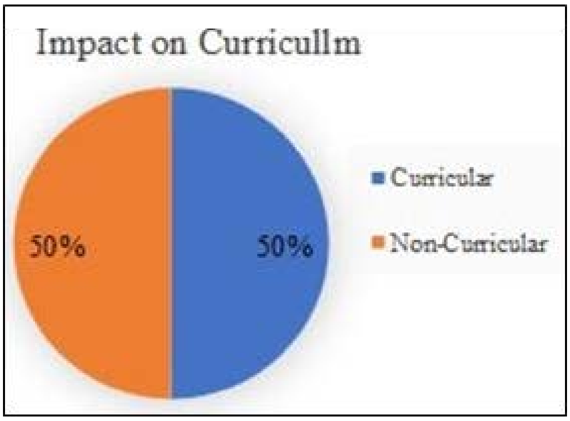

Fig. 8 Integration of the robotics tool in Assistive, Socially Assistive, Social, and Educational Robots

The proposed paper presents the organized study of robotics in education and educational robots with a review of various available research papers. Robotics in education and the educational robot has been introduced and all the related terms are explained in this work. In recent times robotics in education has been implemented to solve various complex problems. Robotics in education proves that natural intelligence plays a significant role in developing the modern education world. To study and highlights the particular role of robotics in education, we have considered more than 50 papers to analyze the role of robotics in the modern education world.

We have studied educational robotics for a learning environment, curriculum impact, robotics tool integration, and activity evaluation for systematic study.

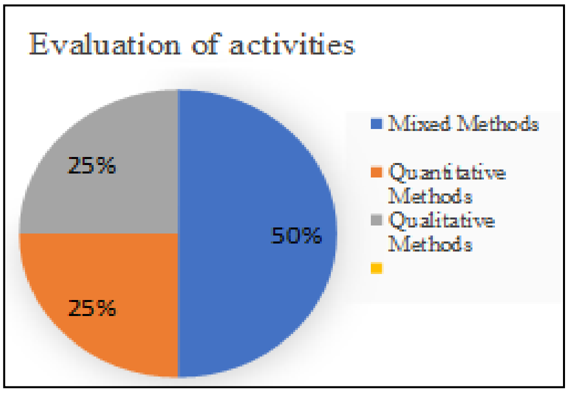

Fig. 9 Evaluation of activities in Qualitative, Quantitative, and Mixed Methods

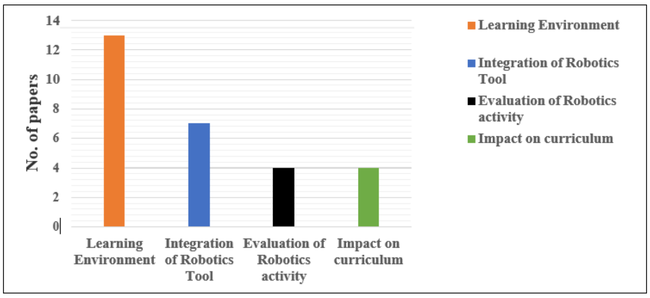

Fig. 10 numbers of papers on robotics in education

The table presents the systematic contribution of the role of robotics and robot in education. In education, many research factors such as year of publication, learning environment, formal and non-formal, impact on curriculum, and so on are highlighted. From the rigorous analysis of available papers, it is clear that the available work on formal learning environments is 66% and 34% on the non-learning environment as shown in fig. 6. In a comparison of available research on the curriculum Fig. 7, it is noticed that equally work done in curricular activity i.e., 50% each. From the comparison shown in Fig. 8, it is observed that the robot used in education is more i.e., 50% when compared to an assistive robot, socially assistive robot, and social robot. The available research paper on the assistive robot is 18% followed by social robots i.e., 16%. In the evaluation of activities (Fig. 9), 50% of work is done on a mixed method followed by a qualitative method and a quantitative method. From Fig. 10, the overall review shows that more work is done on the learning environment followed by integration of robotics tools followed by impact on curriculum and evaluation of robotics in education.

V. CONCLUSION

The main aim of the proposed paper is to highlight the importance of robots in the educational field and to present the recent trends in the field. We have seen that robots in education may play a crucial role in a pandemic situation like covid 19 where the physical education system is collapsed. This paper highlight how educational robotics is grown and in what capacity it has been used in the educational field. The activity of robots has been studied for a formal and informal learning environment, curricular and non-curricular activity, integration of robotics tools, and evaluation of activities. The paper finds the exact work done in the education field by adapting the robot and it also gives the future scope where robotics attention is required more. Still, school education is going on traditionally hence it is needed at present time to adopt the robotics technology in education which will add value to the student's knowledge, will add fun while learning, will show imagination in 3D visualization, and assist physically changed people.

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