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Teacher Opinions on the Role of Educational Robots in Enhancing Programming Skills among Hearing-Impaired Students

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Abstract. This study attempted to identify the role of educational robots in developing programming skills among elementary school students with hearing disabilities and the obstacles to their use from teachers' point of view in the city of Amman in Jordan. This study provides important information to computer teachers in the secondary education stage about the role of educational robots in developing programming skills. Activating the application of robots in teaching reflects the ability to develop creativity and productivity among students and achieves scientific prosperity in educational institutions. The descriptive survey method was employed to achieve the study goals and answer the research questions. A questionnaire was used as research instrument and administered to a sample of 55 computer teachers, who were selected randomly. The results reveal that robots helped students acquire knowledge and programming skills through their design, programming, and construction. The findings also show teachers' lack of experience in dealing with the educational robot, as they had not received training courses that enable them to use it. Students with hearing disabilities can benefit from the latest technologies in developing their programming skills to be part of the market workforce after graduation or to be able to study at universities.

Keywords: artificial intelligence; robotics; special education; students with hearing disabilities; teachers

1. Introduction

Undoubtedly, education is of utmost importance in all areas of life and contributes to the development and progress of humankind and society and to building civilization in various fields. The development and improvement of nations are based on the scientific successes and cognitive achievements they have presented that give rise to human capabilities, the potential to serve humankind, and knowledge increase (Uluer et al., 2015). The level of scientific and intellectual achievements of developed countries, their development, and the extent of their

ability have become standards for benefiting from the latest technologies. The tremendous progress in scientific and technological infrastructure has led to the improvement of communication networks and the expansion of various uses of computers and smart devices. This progress has made developers and designers of various software accelerate in the last decade to develop artificial intelligence and use it in developing programming skills (Herrera et al., 2023).

The educational stages that the learner goes through are of utmost importance in forming their personality in its various aspects, especially at the secondary stage. This stage is considered a transitional stage in the learner's life, as it represents the beginning of their intellectual maturing, personality building, and acquisition of various experiences. This stage is important for the learner's development in various aspects, including mentally, socially, psychologically as well as physically (Yang et al., 2023). The experiences that the learner receives in their first years show clear results in later stages, as the learner begins at this stage to determine their inclinations and interests based on their knowledge and skill formations. This has led to interest on the part of various educational centers and institutions in teaching students computer specializations and sciences in general, and programming in particular. Learning programming skills is one of the prominent educational activities in the basic stage for students with hearing disabilities (Esteve-Mon et al., 2019).

The school is not immune to the tremendous technical development which has caused important qualitative changes in all aspects and has attracted the attention of specialists and those interested in educational affairs, and in their dealings with new technologies. This has raised concerns that artificial intelligence would take the place and function of the human teacher and that digital programs would take over (Cam & Kiyici, 2022). Regarding the status of school curricula on the importance of artificial intelligence, artificial intelligence is seen to be more beneficial to teachers than a threat or deterrent in that it assists them in their tasks. It may also help educational institutions deal with various types of challenges that may confront schools and education centers, such as raising the efficiency of teachers and achieving the requirements that demand needs in the educational stages (Moraiti et al., 2022). Furthermore, it contributes to improving the quality of educational outcomes. Programming and engineering programs of all kinds are some of the foremost areas where robots are used and employed to provide students with the necessary programming skills and knowledge in these fields. This takes place through the design and programming required based on the tasks expected from its use, whether electronically or mechanically, and at any educational stage (Alam, 2022). Perhaps the current trends in terms of trying to introduce artificial intelligence concepts into classroom lessons and the desire to introduce students to this science and provide them with the skills related to it will achieve positive impressions that inculcate positive student outlooks on the future of experimental sciences such as physics and other sciences (McGill, 2012).

The abovementioned clearly shows the importance and necessity of developing programming skills among learners with hearing disabilities because of their close connection to what modern science requires. Indeed, mastering these skills has

become necessary in some scientific specializations related to computer science and modern technology, representing the living nerve of scientific progress and technical development in the current era (Chookaew et al., 2018). Their importance must therefore be realized. Students must be provided with these skills and helped to develop them in various ways. The robot represents one of the latest technologies that can be used to develop these skills, which is why it must be benefited from and exploited in the best ways in teaching (Noh & Lee, 2020). The methods of teaching and developing skills should be updated in a way that is compatible with the requirements of the era of artificial intelligence to raise the potential of learners, meet their educational needs, prepare them for creativity, and contribute to scientific progress and cognitive advancement.

1.1 Problem Statement

Students who participate in computer programming develop the sense that they can control the technology instead of feeling that the technology works on its own. The purpose of teaching programming to students is not so much that they become programmers as it is to achieve the refinement of their skills toward creativity and innovation. When teaching the programming language, it has been found that most of the processes and concepts are abstract for secondary school students and that they find it difficult to embody the knowledge they have learned. According to Alam (2022), teaching computer thinking and programming skills to students with hearing disabilities in the basic schooling stages using an educational robot helped to attract the students and increased their motivation after they had lost interest in and motivation with traditional learning methods. Programming skills are among the important skills that require students to make an effort to master and become familiar with them. However, some students still face difficulty in mastering them and thus are not able to make progress in the field of computers, programming, and computer requirements. Therefore, attention should be paid to developing them and trying to find the best ways to teach them, as it has become a necessary field important for production, creativity, and preparing young people for the future. For this reason, it is necessary to identify the role of robots in developing various skills, especially programming skills, and the extent of activating their use in schools. The obstacles to their use and to activating them must also be identified to find solutions to overcome these challenges. Hence, this study attempted to identify the role of educational robots in developing programming skills among elementary school students with hearing disabilities and the obstacles to their use from the point of view of teachers in the city of Amman in Jordan.

To achieve these aims, the following research questions were formulated:

1. What is the role of educational robots in developing programming skills among elementary school students with hearing disabilities from the point of view of computer teachers in Amman?
2. What are the most important obstacles facing computer teachers in teaching programming skills using educational robots to elementary school students with hearing disabilities in Amman?

1.2 Significance of the Study

This study may provide important information to computer teachers in the secondary education stage about the role of educational robots in developing programming skills. Activating the application of robots in teaching reflects the ability to develop creativity and productivity among students and achieves scientific prosperity in educational institutions. This study may help educational institutions and centers of all kinds and designers of educational curricula and courses understand the application of artificial intelligence techniques, especially the educational robot, in educational curricula and its role in developing programming skills for students. The results of the current study contribute to introducing those interested in the educational process, namely officials in the Ministry of Education in general and educational supervisors in particular, to the role of educational robots. It also emphasizes the importance of activating their use by urging and encouraging teachers to do so and identifies the obstacles that limit their use in teaching and finding the relevant solutions. The goal is to develop programming skills in the best modern ways possible.

1.3 Limitations

The study encountered various limitations. First, the study was limited in theme to the role of educational robots in developing programming skills among elementary school students with hearing disabilities and the obstacles to their use. Second, the sample consisted only of a random sample of computer teachers from private schools in Amman, Jordan. Third, the study was limited to private schools in Amman. Lastly, the study was applied in the academic year 2023–2024.

2. Literature Review

The robot is one of the most prominent modern technological inventions and represents the latest developments in the human mind in the field of technology. It can be defined as an electromechanical device that can perform independent movements and that is programmable to accomplish a variety of tasks (Turan & Aydoğdu, 2020). It is also known as a mechanical machine that can perform various tasks by executing certain commands programmed on computer. Characteristic of the robot is that it can contain sensors through which it can sense the surrounding environment and acts in intelligent ways that differ from other technological devices, helping it to act correctly and make appropriate decisions (Atman Uslu et al., 2023). Robots can interact socially and possess a certain level of artificial intelligence that enables them to act individually and independently. Educational robots are widely used in schools, whether in the classroom or outside them, in extracurricular educational activities to achieve active and effective education in current times. They can be used in various educational subjects, such as geometric design, algebra and geometry, programming etc. Students can acquire knowledge and develop their skills in programming and engineering principles by assembling their robots and programming them to perform the required function (Çakır et al., 2021).

Perhaps the systematic integration of robots into education affords the ability to confront the challenges in the education process today, innovate the latest technical practices in teaching and learning, and accelerate progress toward

achieving the fourth Sustainable Development Goal and the education agenda (Piedade et al., 2020). It is important to achieve the fourth goal of the Sustainable Development Goals and allow all individuals to be able to confront problems and risks. Robots must be integrated into education, programming, and the development of computer thinking skills to support and increase knowledge and skills. The use of robots in education is a good addition to stimulating demand (Angeli, 2022). It is also considered an effective tool in attracting the attention of learners, as it contains factors of suspense and attraction in the teaching of science as well as computers. Furthermore, it creates an atmosphere of emotional interaction upon demand. Some studies have shown that students' performance on tests differed when robots were used in the teaching of language, and students showed improved performance and developed a desire to learn the language by robots instead of traditional methods (Chu et al., 2022).

Robots provide embodiment and the ability to add social interaction to the learning context. Designing and programming a robot requires several students to work within a team to implement the project (Yang et al., 2022). This includes several steps, the first of which is planning the work. Evaluation follows, and each person in the group is assigned a specific role to carry out a specific task. Then, the tasks need to be carried out by following the steps explained to the students. This encourages and develops manual work skills and self-confidence (Tulgar, 2019). As teachers use the tools, parts, and units available in their educational bags to design the structure, they encourage students to apply what they have learned and gleaned from previously received theoretical information, concepts, and laws to a living model and practical aspect. Robotics also allows students to practice designing and installing devices mechanically and electronically, which helps them develop manual labor skills. In addition to the above, using the robot helps to develop self-confidence (Peixoto et al., 2021).

Using robotics encourages a project-based learning strategy. Robots are used to facilitate learning and improve the performance of educational students through project-based learning, as they help students work on implementing various educational activities for many projects in the robotics laboratory. These include producing a car that runs in a certain way, designing a robot capable of detecting and avoiding foreign objects, or designing or producing a robot capable of conducting science experiments (Herrera et al., 2023). Most of the projects implemented in robotics laboratories are realistic examples related to the student's daily life, which leads to the student learning more through their understanding and application of the working mechanisms of the machines and devices that they use daily (Esteve-Mon et al., 2019). In my opinion, the robot is used not only to achieve the desired learning goals but also to achieve enjoyable learning by offering students the opportunity to play freely with the robot and generate new ideas, which develops their attitudes and perceptions positively toward learning. On the other hand, computer programming has become an essential skill in various fields and specializations (Moraiti et al., 2022). As a result, countries around the world are exploring the inclusion of computer science (CS) as compulsory in school curricula.

2.1 Previous studies

Andreeva and Ioannou (2020) suggested interactive robot-assisted psychosocial intervention to help people with disabilities learn to speak by providing them with opportunities to do so via visual and auditory signals. Assisting in the selection process was the SoftBank-created interactive humanoid robot, Pepper. The study showcased several real-life situations where Pepper has helped parents or therapists with language acquisition via auditory, visual, or mixed methods. In this study, speech therapists and technology experts worked together to design a methodology for intense sound stimulation using Pepper. The article explains how to create scenarios for language learning that use visual or auditory-verbal methods. The youngster may engage with the robot via its voice, attitudes, and gestures; alternatively, a human teacher, a serious game, or a tablet can be used to teach the child sign language. These protocols and situations may be customized to fit the family's everyday schedule and adjusted by the robot to meet the child's unique educational requirements.

Marghitu et al. (2023) explored disability as a national priority to ensure that all individuals can use and benefit from technology. AccessCSforALL, Bootstrap, and CSforAll are just a few of the funded initiatives to ensure that the 7.4 million students with disabilities enrolled in K-12 schools have equal access to CS. Equality in opportunity and greater societal preparedness to service a varied population may be achieved by increasing the representation of individuals with disabilities in the technology sector. Bringing CS topics to the attention of children in grades K-12 who are deaf or hard of hearing is the primary goal of the planned initiative.

Ioannou and Andreva (2019) proposed a novel approach that makes use of an intelligent robot to augment processes via play. While there has been great progress in medical technology (e.g., cochlear implants and hearing aids) for children with hearing loss, it is still necessary to combine these devices with specialized treatment for the child to achieve optimum development in both hearing and speaking. This research delved into the potential of the robot for audio-verbal therapy, a method for enhancing both verbal and auditory abilities that does not rely on lipreading or other non-verbal clues to promote communication. Due to NAO's lack of a human mouth, the technology cannot perform lipreading. Nevertheless, this unique feature was utilized in the study to design entertaining and interactive auditory-verbal therapy sessions for six kindergarten-aged children with hearing impairments. As a result, the children were able to enhance their capacity to follow directions using their hearing aids or cochlear implants instead of visual cues in their surroundings.

With the help of seven mentors from the University of Guyana's Robotics Club and Department of Computer Science, DeFreitas et al. (2023) created, revised, and implemented a STEM-Robotics curriculum for 48 students with special needs ranging in age from 11 to 27 in the 2020/21 program. The course material was presented in a hybrid format for around 12 weeks long. The mentors were asked for their thoughts and feelings based on their observations and experiences. They reported seeing an increase in mentees' capacity to think critically, solve

problems, be environmentally conscious, and deliver effective presentations. Most notably, everyone who started the curriculum was able to finish it and graduate. The findings are potentially applicable to similar projects in the future.

Zdravkova (2022) used Second Life (SL) to test the ability of the robot to use hand, body, and facial motions to convey a single word to preschoolers with hearing impairment from a predetermined list of words. Children had to provide useful information to the robot when they had understood the word. This research presented an NAO H25 humanoid robot and a Turkish Sign Language (TSL)-based story-telling game for the preschoolers. A short narrative was produced with carefully chosen phrases that the robot can read aloud and perform using sign language. This was done because most of the children did not know how to read or write and were not acquainted with sign language. Every time the robot used a new sign language term, the children had to use color-coded flashcards to tell the robot whether they had understood or not. The robotics competition included 106 preschoolers. The goal was to test how well children can pick up sign language from a robot and to then compare those findings with those from video-based research.

3. Methodology

The descriptive survey method was used in this study to achieve the study goals and answer the research questions. According to Salaria (2012), descriptive research describes reality in terms of existing phenomena and problems and determines the method that should be seen in the study. Descriptive research describes a phenomenon according to the defined standards of what it should look like.

3.1 Sampling

The sample of this study was limited to 55 computer teachers, who were selected randomly. Ethical approval was obtained before conducting the research.

3.2 Instrumentation

The questionnaire was used as study instrument to determine the role of educational robots in developing programming skills among elementary school students with hearing disabilities and the obstacles to their use from the point of view of teachers in Amman, Jordan. The questionnaire consisted of 42 statements that were distributed over two dimensions. The first dimension consisted of four parts: 1) the level of knowledge and learning related to teaching programming skills using robots; 2) the role of robots in collaborative learning to develop programming skills; 3) the role of robots in developing 21st-century skills related to programming skills; and 4) the role of robots in developing motivation toward learning programming. The second dimension was related to the obstacles to teaching programming skills using robots.

The questionnaire was presented in its initial form to four specialists, or arbitrators, in curricula, modern teaching methods, and information technology. The arbitrators had to express their opinions and suggestions about the wording of the expressions and their suitability to the field to which they belong. They also

had to ascertain the clarity of the instrument, also linguistically, to ensure its readiness for use and that it would measure what it was intended to measure. Amendments were proposed and implemented through adding, deleting, or amending certain phrases, after which the final and completed version was obtained. This yielded a questionnaire adhering to validity measures. The validity of the internal consistency of the tool was verified by applying it to a survey sample that included 24 computer teachers that were not included in the final study sample. The Pearson correlation coefficient was then used to determine the degree of correlation of each statement and the overall degree of each dimension (Table 1).

Table 1: Pearson correlation coefficients for the dimensions of the questionnaire

Dimension	Pearson correlation coefficient	Sig.
The role of educational robots in developing programming skills	**0.954	Significant
The obstacles to teaching programming skills using robots	**0.687	Significant

** significant at 0.01

The Cronbach alpha method was used by applying the tool to the exploratory sample that included 24 teachers, and the results of the analysis are displayed in Table 2.

Table 2: Cronbach alpha coefficients for the reliability of the study instrument

Dimension	Cronbach alpha coefficient
First dimension	
The level of knowledge and learning related to teaching programming skills using robots	0.85
The role of robots in collaborative learning to develop programming skills	0.93
The role of robots in developing 21st century skills related to programming skills	0.84
The role of robots in developing motivation toward learning programming	0.94
Second dimension	
The obstacles to teaching programming skills using robots	0.78
Total	0.86

As seen in Table 2, the values of the Cronbach alpha coefficients for the parts and dimensions of the questionnaire ranged from 0.78 to 0.94, and the overall Cronbach alpha coefficient for the instrument was 0.86. Therefore, all values of the Cronbach alpha reliability coefficient are high and indicate a high degree of reliability of the questionnaire.

4. Results and Discussion

4.1 Results of the First Research Question

To answer the first research question, the mean scores of the necessary values, as well as the standard deviations, were calculated. In addition, the *t* test for one sample was used to determine whether or not educational robots have a statistically significant role in developing programming skills among elementary school students from the point of view of teachers in Amman. The results are presented in Table 3.

Table 3: Mean scores and percentages of the first dimensions of the questionnaire

Dimension part	Mean score	Standard deviation	Rank	*t* value	Level
The level of knowledge and learning related to teaching programming skills using robots	3.70	0.77	3	7.71	High
The role of robots in collaborative learning to develop programming skills	3.62	0.55	4	9.11	High
The role of robots in developing 21st century skills related to programming skills	3.87	0.44	2	16.60	High
The role of robots in developing motivation toward learning programming	4.06	0.63	1	13.61	High
Total	3.81	0.59		11.7575	High

The overall mean score of the first dimension to measure the role of educational robots in developing programming skills among elementary school students from the point of view of computer teachers was 3.81 and the *t* value 11.75. This is because the significance value was 0.000, which is smaller than 0.05. Therefore, there is a statistical significance of 0.05 in the average responses of the sample (3.81). This indicates that the degree of approval for the use of educational robots in developing programming skills for students from the point of view of the participating computer teachers is high.

This result is because robots helped the students acquire knowledge and programming skills through their design, programming, and construction. The main strength of the robot is its capacity to aid students in cohesively learning academic subjects, which raises their level of knowledge. Teachers also provide probing questions before, during, and after educational activities that encourage students to think about their learning, solve problems scientifically, and use the Internet, which develops their 21st century skills. Robots are also used to enhance and enrich learning by allowing students to work in groups to implement various activities in the classroom. Furthermore, it characterizes the classroom environment with interaction and teamwork and encourages the acquisition of cooperative work skills, which develop students' cooperative learning skills. In addition, the educational robot has a distinctive and attractive design. It can also be programmed to move, dance, light up, and respond to voice commands. It also

displays information in an interesting way, which increases motivation for learning.

This finding agrees with the finding by Ioannou and Andreva (2019), who indicated that there is an urgent need for students to learn coding and robotic applications to be able to acquire 21st century skills. In further corroboration, Zdravkova's (2022) findings show that teaching computational thinking using robots attracts the attention of students who have lost interest and motivation, providing them with abilities that enable them to learn lifelong.

4.2 Results of the Second Research Question

To answer the second research question, a one-sample *t* test was used to determine whether the obstacles facing computer teachers in teaching programming skills using educational robots to elementary school students with hearing disabilities in Amman were statistically significant or not. This was done by determining the significance of the difference between the average scores of the respondents' responses and the hypothetical average of the questionnaire. Table 4 presents the results.

Table 4: Results of the *t* test to indicate differences in the obstacles facing computer teachers in teaching programming skills using robotics

	Statement	Mean score	Standard deviation	Rank	*t* value	Level
1	Teachers fear that their role in the education process will be reduced	3.92	1.21	9	6.34	High
2	Weak technological infrastructure	4.08	1.07	7	8.32	High
3	Classrooms are not prepared to use educational robots to teach programming	4.56	0.51	4	25.60	Very high
4	Poor qualification and training of the teacher to use the skills of using robots in teaching programming	4.75	0.47	3	31.48	Very high
5	The lack of knowledge of students in using robots prevents them from using educational robots in learning programming skills	4.82	0.39	1	10.64	Very high
6	Teachers' poor convictions and confidence in teaching programming through an educational robot	4.28	0.95	6	10.92	Very high
7	Parents' fear of using educational robots to teach programming	4.04	1.16	8	9.16	High
8	Poor teacher skills in classroom management when using an educational robot to teach programming	4.27	0.45	5	10.55	Very high
9	Lack of time allocated for teaching programming using a robot	4.74	1.12	2	35.20	Very high
10	Students' lack of skills in using phones, smart devices, and robots	3.52	0.46	10	2.45	High
Total		4.298	0.779		15.066	Very high

Six statements were rated very high. These were: "Classrooms are not prepared to use educational robots in teaching programming"; "Poor qualification and training of the teacher to use the skills of using robots in teaching programming"; "The lack of knowledge of students in using robots prevents them from using educational robots in learning programming skills"; "Teachers' poor conviction and confidence in teaching programming through the educational robot"; "Poor teacher skills in classroom management when using an educational robot in teaching programming"; and "Lack of time allocated to teaching programming using the robot". Furthermore, the four other statements were rated high. These included: "Teachers fear that their role in the education process will be reduced"; "Weak technological infrastructure"; "Parents' fear of using educational robots to teach programming"; and "Students' lack of skills in using phones, smart devices, and robots". The overall mean score for the obstacles dimension was 4.30, which means that the degree of obstacles that secondary school teachers may face when teaching programming skills using educational robots is very high. As for the responses of the respondents, the arithmetic mean values ranged between 3.50 and 4.83. Furthermore, statements 5 and 9 ranked first and second, respectively, with a very high degree, and statements 1 and 10 ranked second to last and last, respectively, with a high degree.

These results are due to the respondents' lack of experience in dealing with the educational robot, as they had not yet received training courses that enable them to use it. This will be reflected in the students' knowledge of using educational robots to learn programming skills. In addition, the time allocated to teaching programming skills using the robot needs to be increased, with a specific time allocated to teach programming. This finding shows agreement with Andreeva and Ioannou (2020), who showed that at the beginning of long lessons, it takes time to prepare and operate robots. This finding also agrees with that of Marghitu et al. (2023), which showed that the lack of opportunities for exchanging experiences and information in the field of using educational robots is the most prominent difficulty facing teachers.

5. Conclusion

This study attempted to identify the role of educational robots in developing programming skills among elementary school students with hearing disabilities and the obstacles to their use from the point of view of teachers in the city of Amman in Jordan. The results revealed that the robots helped the students acquire knowledge and programming skills through their design, programming, and construction. In addition, the educational robot has a distinctive and attractive design and can be programmed to move, dance, light up, and respond to voice commands. The findings also highlighted the respondents' lack of experience in dealing with the educational robot, as they had not received training courses that enable them to use it. Students with hearing disabilities can benefit from the latest technologies in developing their programming skills to be part of the market workforce after graduation or to be able to study at universities. The findings indicate the need to raise awareness of the importance of programming among students and their parents. Teachers also need to increase their knowledge of the

latest technologies related to robotics, especially those related to students with special needs and hearing impairment.

6. Recommendations

The study recommends motivating teachers to expand the scope of using robots in their teaching activities and practices in teaching programming skills because of their major role in that from the teachers' point of view. It is important to provide the necessary training opportunities for teachers on the use of robots in the teaching and explanation processes and to prepare students to use robots. The Ministry of Education, also, can prepare the infrastructure of schools by developing an educational environment suitable for the possibility of using educational robots. It is also suggested that studies be conducted on the requirements for using robots in public schools in general education investigating the reality of using educational robots in colleges, learning institutes, and general education schools. In addition, the impact of using educational robots on developing programming skills for students at different levels of general education can be researched.

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