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The Significance of Training Student-Teacher Lecturers in Pedagogical Robotic and Coding Skills

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Abstract

The development of students' robotics and coding skills is globally emphasised to encourage employment creation for the future. Future generations need digital, creative thinking, problem-solving and entrepreneurial skills for their careers. Therefore, effective training of lecturers who are teaching student teachers robotics and coding is important to ensure the development of required skills. A training session was held to establish student-teacher lecturers' (n=20) perceptions about the significance of teaching and learning robotic and coding skills. Participants were purposefully selected from a University of Technology and engaged in a training session on the fundamentals of robotics and coding skills. Before and after the training sessions data was collected and qualitatively analysed based on activity theory as a theoretical framework for this study. The results showed that student-teacher lecturers did have sufficient prior knowledge of what robotics and coding entail. It was also found that coding and robotic skills could contribute to the development of creative, inventive, imaginative, and analytical thinking skills that could assist students in their future careers. The significance of robotics and coding training could allow lecturers to gain more resources and improve teaching and learning strategies specifically in the fourth industrial era where knowledge of robotics and coding is essential. It can be concluded that lecturers must comprehend the significance of educational robotics (ER) and be aware of the most effective pedagogical approaches to apply ER activities in the classroom.

Keywords: *Robotics; Coding; Pedagogical Robotics Skills; Student-Teacher Lecturers; Activity Theory; Educational Robotics; Pedagogical Robotics*

Introduction

Twenty-first-century technology applications require educators, teachers and students to stay abreast with educational robotics (ER) or pedagogical robotics (PR) skills (Sanfilippo et al., 2022). Educational robotics aims to introduce students from an early age to interactive robot programming and coding where they learn to work in a team and develop creative thinking and problem-solving skills needed for their future careers (Papadakis et al., 2021). Moreover, Taylor (2016) indicates that student engagement and personal development in understanding concepts in science, technology, engineering and mathematics (STEM) subjects can be improved by making use of robotics and coding at an early age. Robotic skills can be defined as the ability to construct automated systems that consist of electronics, sensors and software that can perform certain tasks independently when programmed (Haidegger, 2021; Wehbe & Williams, 2021).

The Department of Basic Education (DBE) in South Africa has scheduled the pilot implementation plan for robotics and coding in the Grade R to Grade 9 curriculum from 2021 to 2025. However, school teachers and lecturers teaching student teachers are not adequately trained for the pilot implementation plan. Few teachers are qualified to teach robotics and coding and not all university lecturers can develop student teachers' robotic and coding skills (Shiohira, 2021). Furthermore, Ettershank et al. (2017) argue that science, technology, engineering and mathematics (STEM) education poses a challenge for the Department of Education as teachers in the schools do not have the required skills to teach these subjects. Schools are mostly unable to fund the training of teachers in developing coding and robotic skills and to finance costly specialised robotic types of equipment to teach learners advanced robotic skills (Martins et al., 2015).

Schina et al. (2021) emphasise the importance of effective training when teachers integrate and teach education robotics (ER) in the core curriculum because it impacts digital skill acquisition, which includes coding. Bers et al. (2013) suggest that before training can commence, participants involved in robotic training must first understand the potential benefits of ER and the best pedagogical approaches for successfully implementing ER activities in class. Additionally, Sisman and Kucuk (2019) assert that some lecturers are not aware of the benefits of ER and this may be caused by a lack of training in educational robotics and coding for lecturers in institutions of higher education.

Various studies have been conducted regarding robotics and coding, but in South Africa limited studies have focused on the training of student-teacher lecturers in developing robotics skills (El-Hamamsy et al., 2021). ER can be a strong aid when students acquire knowledge as it enhances learners' process of active knowledge-construction (De Carvalho & De Mazalhães Netto, 2021; Silva et al., 2019). However, Fares et al. (2021) point out that implementing the plan of Basic Education requires all teachers to be effectively trained in teaching robotics but that there is still a lack of effort to employ ER training for lecturers and teachers in the education field (Aldemir et al., 2021).

ER is still unknown in the South African educational context and is mostly applied in private schools (Maree, 2021), which requires the training of lecturers, student teachers and teachers. Therefore, this study aimed to conduct training of student-teacher lecturers and establish the significance of these training sessions when teaching student teachers pedagogical robotics and coding skills. The findings are based on the following research question:

What is the Significance of Developing Student-Teacher Lecturers' Pedagogical Robotic Skills in Higher Education?

Chambers and Carbonaro (2003) suggest that integrating the technology of robotics into the curricula of learners is a difficult task and teachers in various schools find it challenging to teach learners new technology. The reason could be that teachers are not technology literate themselves and are not always able to teach their learners these new technology skills. Major et al. (2014) stress the importance of effective teacher training in educational robotics to assist them in teaching coding and robotics effectively.

Schina et al. (2021) reviewed literature about the teaching of educational robotics and found that teachers need to understand the benefits of ER and should be knowledgeable about the best pedagogical approaches to implement ER activities in the classroom. Additionally, Bers et al. (2013) point out that various factors influence the effective training and teaching of coding and robotics, such as the attitudes of teachers in developing their robotics and coding skills and the teaching practices applied in teaching robotics and coding skills.

Adler and Kim (2018) assert that training should be continuous, where time is set aside daily for the training of teachers in robotics and coding. They also found that teachers who were well trained in coding and robotics could engage their students in hands-on activities in collaboration with their classmates, which encourages the development of social skills. Hestness et al. (2018) further acknowledge that when teachers have prior knowledge of computational thinking, acquiring robotics and coding skills is less difficult.

In terms of contextual factors and logistics when teaching robotics and coding skills, collaboration and partnerships among various experts among teachers and media professionals are encouraged to showcase and create awareness in the public (Leonard et al., 2018). In establishing the significance of developing student-teacher lecturers' pedagogical robotic skills in higher education, the research study was based on activity theory as developed by Vygotsky.

Theoretical Framework: Activity Theory

According to Morf and Weber (2000), activity theory is a conceptual framework grounded in the idea that activity is primary and precedes the acquisition of goals and the development of skills. The four elements of activity theory that assisted in guiding this study involve the ***tools*** used, the ***subject*** of study, the ***objective*** of the study and the ***outcome***.

When applying activity theory in this study, the four components were used as follows:

The ***tool*** is the mediating device by which the action is executed, which in this study comprised the robotic kits that were used. The ***subject*** is the person being studied – the lecturer of student teachers; the ***object*** is the intended activity – the activities during the workshop to reach the ***outcome*** and which included fundamentals of the electronic circuit theory course in which they learned about sensors, processing real-world data and automation and an introductory programming course where participants built engineering-based projects such as a home automation system and an autonomous car. The outcomes of the training course aimed to introduce participants to the fundamentals of electronic circuit theory, the operation of electronic sensors; infrared sensors, buzzers, and temperature sensors; the use of the Arduino microcontroller theory in coding robots; installing digital and analogue input and outputs; automation and system integration; programming logic: function and code management when programming a robot. Thus, activity theory served as a framework for establishing the processes that could be used when student-teacher lecturers incorporate robotics and coding in the curricula of student teachers.

Method

A qualitative research case study was conducted to establish the significance of developing 20 purposefully selected student-teacher lecturers' pedagogical robotic skills in a higher education institution.

Training sessions were arranged to establish the significance of training participants in robotics and coding. The training sessions lasted two consecutive days and were conducted by outsourced service providers who were experts in the field of training robotics and coding skills. Before the training sessions commenced ethical clearance from the institution and the consent of participants were obtained. Data was generated from open-ended questionnaires that were completed by participants before and after the workshop was conducted.

Before the face-to-face training sessions commenced participants were registered for online training support on the service provider's learning platform. The study materials were also available on the service provider's online platform to support lecturers during and after the training sessions.

The participants were divided into two groups consisting of ten participants in each group. Each group had its own instructor for the entire two days of training. The instructor made use of hands-on activities, robotic kits, PowerPoint presentation slides, demonstrations, and videos to teach lecturers the coding of robots.

During the training session, all participants were provided with a robotics kit that was used during the practical sections of the training. The training was interactive, whereby participants were given a chance to ask the instructor questions if they needed to clarify anything before discussing any new aspect of the content. The goal of the training session was to reach the learning outcome that would enable student-teacher lecturers to incorporate robotics and coding skills in curricula when teaching diverse STEM subjects.

During the data collection and analysis processes of this study, researchers ensured participants that all data remained confidential and anonymous.

Results

Open-ended questionnaires were completed by all participants before and after the training sessions to detect student-teacher lecturers' understanding of the significance and application of robotics and coding in real life.

Tools: Robotics and Coding

In response to the question, *What is the significance of robotics?* one participant said: *"In this day and age technology manages and controls our daily lives in almost every aspect of it".* Others responded by saying that "*Robotics is a skill required in the fourth industrial revolution* [4IR]. *Knowing it will help me to share the knowledge with my students so that they acquire the latest skills required by industries".* According to other respondents, *"It is a much-needed skill – adapt or perish, technology is the future, we need to train our students in these skills".* Furthermore, "*the world is changing to robotics to save time (time is money). Big jobs can require one operator instead of 20 people doing it manually".* Participants further responded as follows: *"a notion of 4IR is advocating for a global player. Robotics skills have a potential to advance our students in becoming global players".* Robotics technology increases the rate of productivity; it skilfully enhances the quality of human lives; in the fourth IR, people need these skills to keep up with the teaching trends and life skills; robotics skills give one meaningful tools for current teaching and learning; it enhances learners' skills as well as interest in the creative and development fields; robotics helps in developing critical thinking skills that will benefit learners.

Answers related to the advantages of robotics were the following: *"Students will be exposed to the latest methods of teaching and learning as is the case with the first world countries. For me it also helps me to see how things are done technologically wise in other countries".* Another participant mentioned that *"students will use the knowledge in their respective workplaces, and they will share with future colleagues".* Respondents believed that they would gain currently required skills. Robotics and coding training "*will contribute to innovate creative and critical thinkers that can create new job opportunities"*. Moreover, coding helped in teaching mathematics: "*I would like to understand what coding is all about, especially in my content area of Mathematics".* Being competent in coding robots is essential, especially in the era of 4IR, to enhance teaching methods and give teachers access to more resources for teaching and learning. Interestingly, a participant indicated that robotics could also enhance physical education. Apart from these responses, it was reflected that robotics was beneficial to "*translate information into meaningful data"* and *"to broaden the scientific research field and contribute to the available literature"*.

Some of the responses from the participants emphasised the importance of robotics and coding for lecturers, teachers and students as follows: *"Robotics and AI are part of the 4IR which can extremely increase the quality of online teaching and learning".* Thus, it increases the quality of online teaching and learning. From the lecturers' point of view, it was stated that "*Lecturers can equip even more experienced teachers. They can also conduct research and relate their skills with the latest content and skills required by industries".* Furthermore, it was stressed that lecturers and student teachers should be trained to teach coding and robotics as the DBE had implemented coding and robotics in school curricula from 2023. Students could design their own projects with the help of this training. Furthermore, robotics could help students to invent more models that could be applied in daily lives in the future. They would learn and understand the simulation of robotics and coding, and some respondents said that it would assist in developing creative thinking skills and problem-solving skills: "*It will encourage learners in technical skills which are needed to deal with unemployment and also allow learners to be critical thinkers and be innovative"*. Some agreed that "*knowledge can improve pedagogical skills".* In addition, "*today's life is speedup with robotics; teachers, lecturers and learners will help in increasing the economy."*

Subject: Student-teacher Lecturers

In defining robotics, some of the respondents highlighted that robotics is similar to programming. This is evident in the following response: *"The word robotics to me indicated programming stuff to work like robots. Since the buzzword is that in future we will be using robots for everything".* According to other respondents, robots perform activities that are naturally done by human beings. Furthermore, *"[the] use of [the] model works electrically according to the way you design or program it".* Robotics "*also automatise[s] a system that can execute various functions and actually relie[ve] extra workload for me*". Other respondents felt that robotics meant relief of extra workload; working of machines; coding and software development; the mechanisation of the productive process of goods and services; construction of objects on the computer; and expression of teaching and learning through technology.

When questioned about the integration of robotics in the curriculum it was suggested that *"robotics skills can be embedded in the curriculum covering teaching media and technology within didactics subjects and professional studies".* Furthermore, the life skills subject can be integrated into the content. One of the respondents recommended that *"In the physics laboratory, the technician can use Arduino to bridge the gap between levels 1 and 3. Students can do different projects like models that detect fatal injuries, alarm systems and more".* According to another participant, "One module should focus on theory and practice at the first year level of study and from the second to the fourth level, robotics skills should be implemented fully in all the modules." Moreover, there was a suggestion to add in *"Computer Applications Technology and a stand-alone module for FET and GET".* Another participant suggested that *"the fundamentals of learning the theory could be introduced earlier to the level ones. Block-based should be for the second years, once the theory is learned to saturation".* Some recommended that robotics should be integrated as a subject — covering different disciplines instead of forming a small section of other STEM subjects: *"I recommend it as a different subject — covering different disciplines instead of being a small part of every subject. The lecturer can be an expert – exposing students to the different possibilities"*.

When participants were asked how the training sessions measured up to their expectations, they replied that *"theory and practice made the training session a hands-on experience. Learning and doing"*. Furthermore, they indicated that coding the robot added extreme value to their understanding of how a robot functions. One respondent said that *"I am now able to understand how coding and simulations work"*; whereas another responded: *"It met more than my expectations as I had to build my own robot"*. Respondents understood how robotics were coded and could change the demands of society in the future. A few indicated that they were amazed by the training manual and the robotic kit they used during the training session and had not expected that they would be able to build an automated car using sensors and coding.

In answering the question of how it benefited them to work in teams during their training sessions, some participants emphasised the following: *"My colleagues assisted me in understanding the coding process and uploading data instructions for the robot when I got stuck"*. Furthermore, they asserted that working together forced them to concentrate intensively and assist each other in not making mistakes. Thus, by helping each other, they avoided unnecessary faulty connections and contributed to the clarification of certain coding language that was important to connect the robot to certain automated functions. This collaboration was essential as they also learned from each other during the practical sessions. Moreover, they were able to help each other in class. One respondent answered, *"My peers were able to coach me when I got stuck"*. Moreover *"sharing ideas and being able to learn and assisting one another when facing coding challenges"* was mostly highlighted by participants. By exploring a sense of interdependence, they helped each other when they encountered challenges. Another respondent stated, *"Colleagues were able to assist me in case I missed the facilitator's instruction"*. The ability to share knowledge and skills contributed to effective teamwork and the effective training of lecturers during the sessions. Each participant was glad to use their own robotic kit throughout the hands-on training, which worked well. Sharing ideas, arguing possibilities, and discussing problems/ solutions were identified as valuable contributions during teamwork.

Object: The Activities

Most participants highlighted the coding section as interesting: *"Coding. as it can give instructions to robots to perform a certain task"*. Some emphasised the simulation of electric circuits and the programming of infrared light sensors. According to a participant, *"Both days were interesting. I enjoyed and learned from the hands-on practical activities. I now have an understanding of simulation and how important robotics and coding are"***.** One of the participants said: *"Building a car and making sure it can move and how it can avoid obstacles was very interesting*". Other participants felt that micro:bit sunlight sensors, real-life experiences, and practical activities were interesting.

When discussing challenges, participants felt that *"too much content is presented within a short space of time"*. In this context, they stressed increasing the time for training. Some respondents faced difficulties with installing the software: *"Could not install the software training manuals as a hard copy to be distributed"* and *"Terminologies used in robotics and coding and the names of the different components"* were challenging for some respondents. Other issues raised were as follows: connecting the wires; connecting programming with the content of the participant's field of specialisation; internet Wi-Fi connections; building the cars from scratch. Apart from these issues, one of the participants said that "*I need to work faster as I took longer to complete activities",* while another said that the tools in the kit box were too small to handle.

Participants emphasised that practical engagement in class made it easier for them to understand the theory and putting the theory into practice when practising in class increased their comprehension of coding robots. Participants became confident that they were able to code even though they had no previous experience. According to a respondent, *"I was able to collaborate with others during the* *practical sessions that were enjoyable while I was learning a new technology I had never experienced before"*. They gained the confidence to practice coding by themselves. Moreover, it was reflected that during the training sessions theory was well connected with practice; setting up a code and seeing its implementation was the best part of the training; they could access information rapidly from their study manuals; they were able to visualise and work with the different robot components and operate them; and they were enabled to see the input and output of all the robot's technology connections. The consolidation of new knowledge and helping each other were highlighted after the training.

When participants were asked about the advantages of using the robotic kit and other additional online study materials, they had diverse views concerning the advantages of using a small-scale robotic kit and online study materials, as follows: understanding the theoretical presentations was made simple by the robotic kit, *"It assisted in putting the theory to practice"*. "*The robotic kits helped a lot, but I still need to practise more and master the theory"*. Tools increased their comprehension of simulation and the rationale behind why electric circuits are taught. According to a participant, *"I was able to build a car from scratch"*; while another said: *"By performing and simplifying some abstract concepts I was able to understand how the coding and automatization of the car links"*. Some of them said the robot kit really assisted and it would be helpful if they could practise more after the training sessions. One participant excitedly replied that *"seeing what we developed or coded was actually working was very exciting and inspiring to learn more and build my own design"*. Moreover, another said that the kit and the study materials *"assisted me to answer questions, to do research and go back on the PowerPoints to understand unclear concepts"*.

OUTCOME: What Was Learned

Responses to the question of why training in coding and robotics is essential varied. A respondent indicated that it facilitated *"understanding robotics and its importance in our daily lives, especially teaching and how it will benefit the poor of the poorest and those who are in villages"*. One of the participants wanted to *"acquire the skill of programming a robot and be able to use it in class"*. Some wanted to learn *"various teaching and learning strategies in applying robotics when training student teachers"*. Another participant wanted to find out "*how robotics work in order to apply simulation in Mathematics"*. While some participants were interested in "*the integration of computer technology in the teaching and learning of natural science",* others were attracted to **"***using technology to enhance the quality of teaching, learning and assessment"*. In essence, most of the participants wanted to comprehend the fundamentals of robotics and be able to apply this knowledge to their area of expertise when teaching student teachers. In summary, most of the participants wanted to know how software programmes and robotics could be integrated to improve teaching and learning and how they could develop and utilise various software programmes to improve their pedagogical methods of instruction and evaluation.

In responding to the question about the impact of developing robotic skills on student teachers, most of the participants believed that students would be exposed to the most recent teaching and learning techniques: *"Students will be exposed to latest methods of teaching and learning as is the case with the first world countries. For me it also helps me to see how things are done technologically wise in other countries"*. Knowledge of robotics "w*ill contribute to innovate creative and critical thinkers that can create new job opportunities"*. The main impact could be that "*students will gain currently required skills";* students would have a better understanding of robotics and coding in the advent of 4IR. "*I want to know how robotics can help in physical education and it will benefit my students in using robotics to facilitate physical education"*. Students could use robotics and get a better understanding of how robotics could be applied in practice.

The participants were questioned on how they would apply robotics and coding skills in the future. In their comments, a few of the participants highlighted the fact that *"the provision of study* *material and ideas will assist in the implementation of robotics and coding skills".* Some were inspired by the fact that they could complete the robotics and coding on their own. They were also going to experiment to see how robotics could be incorporated into the physics curriculum. Teaching secondary school students and how to include robotics in the curriculum was also a concern. Additionally, training would empower them to teach the student teachers coding and robotics in class. On the other hand, student teachers would be able to train others and practice their skills in more innovative robotic projects. Another participant hoped to be *"designing robots that can excite learners to participate in physical education with minimal human contact"*. Other responses can be summarised as follows- *"I look forward to writing codes for mathematics lessons and making my teaching more interesting*"; *"I think I can integrate coding and robotics within my teaching practice to make my teaching more interesting".* It can also be beneficial in cooperative activities and training of one another – *"meeting with instructors and peers. Share creative ideas – I suggest that lecturers or student teachers should prepare a presentation of how robots can be used/ implemented in their field of specialisation".* Some respondents suggested that they could *"impart the knowledge and skills to improve and support student teachers to implement robotic and coding skills for the future in their classroom".* Another respondent enthusiastically replied that he would build his own robot with different functions and then teach his students how to do it.

In the context of developing additional skills during training sessions, participants replied that *"Electrical connections skills, coding and how sensors work"* are very important. More confidence in basic coding was required. According to a participant, knowledge of using Tinkercad could be useful: *"Knowledge of using Tinkercad to simulate electric circuits in class. This will help me to train my student teachers so that they do not struggle when they go to schools that do not have laboratories"*. Some of the respondents also highlighted that terminology used in robotics and coding; motor skills; creative and critical thinking skills, electronic-programming; working in a team; a science lab, and connecting the kit and technology skills were some essential additional elements to be considered when training coding and robotics.

Discussion

In recent decades, the development of robots has stimulated educators' and researchers' curiosity in learning more about how to apply pedagogical strategies and methods to support learners in developing skills in coding and robotics (Alimisis, 2013). According to Tzagkaraki et al. (2021), educational robotics is a developing field that could have a massive influence on how science, technology, engineering and mathematics (STEM) subjects are taught in all grade levels, from preschool to higher education institutions. Educational robotics, an innovative educational technology, may provide engaging, hands-on experiences in a captivating educational setting.

Participants had various interpretations and views about the concept of robotics. However, they were aware that robots perform activities that are naturally executed by human beings, and robots are created to relieve extra workload and to operate machines (Li et al., 2022). The results revealed that the participants had prior knowledge of what robotics entails.

Concerning the importance of robotics, the participants revealed that robotics manages and controls the daily lives of people and is a 4IR skill. Furthermore, robotics is a much-needed skill and helps in saving time. Additionally, it was found that robotic technology increases the rate of productivity; it skilfully enhances the quality of human lives and people need these skills to keep up with the teaching trends and life skills required by the 21st century (Babalola & Omolafe, 2022). Robotics will benefit learners, enhancing their creative skills and developing critical thinking skills. These study results are similar to the study findings of Sanfilippo et al. (2022) and Papadakis et al. (2021), who suggested that educational professionals, teachers, and students must stay abreast with the development of competencies in pedagogical robotics or educational robotics to adjust to the demands of 21st-century technology. The goal of educational robotics is to expose learners to collaborative robot programming and coding at a young age, where they can learn to collaborate with others and acquire the necessary critical thinking and problem-solving abilities for their future employment.

It was also found that robotics and coding training would enable student teachers and lecturers to integrate technology into the teaching and learning activities of the subjects they teach (Esteve-Mon et al., 2019). Additionally, the development of coding and robotic skills could support the development of inventive, imaginative, and analytical thinking skills that contribute to future work creation. Individuals who work in the STEM fields are particularly interested in learning more about coding because it relates to and could significantly develop learners' mathematical skills. To improve teaching strategies and allow teachers access to more resources for teaching and learning, particularly in the 4IR era, knowledge of robotics and coding is essential (Mpungose, 2020). More insight into what robotics entails, how robots operate, how to convert information into useful data to expand the scope of scientific research, and how to add to the body of existing literature could be detected from effective training sessions in coding and robotics.

Hestness et al. (2018) and Leonard et al. (2018) emphasised in their studies that learning robotics and coding abilities was made simpler when instructors had prior knowledge of computational thinking. While educating robotics and coding abilities to display and promote public awareness, coordination and alliances among diverse experts, such as educators and media practitioners, are promoted in terms of situational considerations and logistics (Paniagua & Istance, 2018).

It was further found that lecturers were curious to learn how robotics would assist disadvantaged learners hailing from rural communities, as well as how one could learn to programme a robot and use it in class. Additionally, some student-teacher lecturers were interested in utilising computer technology to improve the quality of education, understanding, and evaluation, while others aimed to understand the foundations of robotics and how to use this knowledge in their field of competence and to understand how robots may be used in education and learning. The study results align with those of Schina et al. (2021), who revealed that teachers must comprehend the advantages of ER and be aware of the most effective pedagogical approaches to apply ER activities in the classroom. Major et al. (2014) also noted the necessity of providing training to those who are expected to instruct educational robotics so they can do it competently and successfully.

The application of activity theory as a framework for this study assisted in the analysis and understanding of training the student-teacher lecturers on the significance of robotics and coding skills as it offered a holistic and contextual method to support this qualitative research study (Hashim & Jones, 2007).

Conclusions

The desire to learn the skills needed by 21st-century society has grown drastically in recent years. Learners are now exposed to technology, which calls for comprehensive curriculum policies that integrate technology with creative reasoning and problem-solving in education contexts. One of the most widely popular methods to accomplish this objective, as well as to raise individuals' self-confidence and curiosity in the area and provide knowledge about relevant career prospects, is to educate them in STEM subjects at a young age. Youngsters are naturally curious and have the drive to experiment; the early class setting is especially rich in opportunities to do this by actually participating in STEM activities.

Therefore, assisting learners in developing skills they will require in the long term, including more technologically oriented teaching tools in early childhood education curricula, may offer considerable advantages. As a component of STEM education, educational robotics (ER) includes a wide variety of broad information and enables the translation of any particular discipline into a more complete educational environment. This study revealed the significance of teaching the student-teacher lecturers about educational robotics so that they can transfer their knowledge to those they are teaching. The student teachers will then use these robotics and coding skills when teaching the learners at different primary and secondary schools. ER has attracted the attention of academics and legislators from all over the world, particularly as a useful tool for developing learners' social, psychological, and mental abilities from preschool to higher education levels, in both mainstream and special education environments.

Recommendations

Given the importance of pedagogical robotics, educational robotics and coding skills, this study recommends open instructional and technical practices for the teachers who are already in the field of teaching, especially in townships and rural schools, to be trained on pedagogical robotics and coding skills.

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