

## PROSPECTS AND CHALLENGES OF ROBOTIC TECHNOLOGY IN CHILDREN'S EDUCATIONAL DEVELOPMENT

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### Abstract

*The advancement in robotics has led to the increase in the demand for robots in children's education for motivating pupils, improving motor skills, facilitating instructions, increasing pupils' interest levels as well as improving learning skills. Educational robots have been adopted to aid the teaching of subjects such as mathematics and physics because of their power to capture the imagination of younger people. Thus, they are deployed to elucidate difficult abstract concepts. Robots are also used as therapeutic devices for children who have difficulty in coordinated interactions with their environment and other people. Furthermore, educational robots are used to adapt to the actions and mood of individuals. Individuals can become emotionally attached to robots, thereby increasing the bond between the robot and the individual as well as the amount of concepts learnt from the robot. Hence, robotic technology aids the cognitive, psychomotor and the affective development of children. However, robotic technology is plagued with diverse difficulties such as staff training, technology reliability, emotions and deception, and resistance to change. Nevertheless, the use of robots in children's education is still at its infancy. Thus, this study appraises the benefits and challenges of educational robots on children's educational development.*

**Keywords:** educational robots, children's educational development, robotic technology

### Introduction

The general use of robots in the society is fast becoming exponential. Robots have been increasingly deployed in healthcare, agriculture, mining as well as in Education. Robots that are deployed in the educational system are typically known as educational robots. The impacts of educational robots are crucial for the development and intellectual growth of children and teenagers (Mubin, Stevens, Shahid, Al Mahmud and Dong, 2013). For instance,

educational robots possess the ability to capture the imagination of younger people. Hence, they are used to elucidate difficult abstract concepts. Educational robots are also used as therapeutic devices for children who have difficulty in coordinated interactions with their environment and other people. Furthermore, educational robots are used to adapt to the actions and mood of individuals. They can also be used as entertaining platforms to learn diverse subjects such as Computer Science, Engineering and even Languages. Consequently, educational robots enhance the academic performance of students who deploy them for learning (Miller, Nourbakhsh and Siegwart, 2008). In addition, educational robots are used to adapt to the actions and mood of individuals. Hence, individuals can become emotionally attached to robots, thereby increasing the bond between the robot and the individual as well as the amount of concepts learnt from the robot. Consequently, educational robots aid the cognitive, psychomotor and the affective development of children. However, robotic technology is plagued with diverse difficulties such as staff training, technology reliability, usability, the morphology or the shape of the robot, safety, emotions and deception, and resistance to change. Globally, the use of educational robots in children's education is still at its infancy (Rouhiainen, 2019). Hence, this study critically appraises the benefits and challenges of educational robots on children's educational development.

The paper is divided into six sections. Section 2 examines the concept of educational robots, sections 3 and 4 discuss the importance and challenges of educational robots on children's development, section 5 concludes the study.

## **2.0 Educational Robots**

The term robot is derived from the Czech word *robota* which connotes forced labor. The word robot was created by a Czech novelist named Karel Capek (Capek, 2001). Capek used the word robot in a 1921 play titled *Rossum's Universal Robots (R.U.R.)*. However, there is no standard definition for robots. Nonetheless, the Robot Institute of America defines a robot as a reprogrammable, multifunctional manipulator designed to move material parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks (Kumar, 2014). Davison (2016) also views a robot as a physically-embodied, artificially intelligent device that has the ability to sense and actuate. Robots can be classified into three categories. These include industrial robot, service robot and social robot. Industrial robot according to the Robotic Industries Association is an automatically controlled, reprogrammable, multipurpose manipulator that is programmable in three or

more axes which may be either fixed or mobile for use in industrial automation applications (Iroju et al., 2017a). Engelhardt and Edwards (1996) define a service robot as a system that functions as a smart and programmable tool, which can sense, think and act to benefit or enable humans to extend/enhance human productivity. A social robot is defined by Bartneck and Forlizzi (2004) as an autonomous or semi-autonomous robot that interacts with human beings by following the behavioral norms expected by the people with whom the robot is intended to interact. Social robots adapt to a changing environment, make their own decisions, interact with human beings and socially fit into the human environment. From the aforementioned it can be deduced that industrial robots are mainly used for industrial purposes such as manufacturing of objects, service robots are used for providing services and performing tasks such as vacuuming, lifting and cooking. Social robots on the other hand also perform tasks for human beings but they are different from social robots because they interact socially with human beings.

The history of educational robots can be traced to the introduction of the Heathkit Hero-1 in the early 1980s (Miller et al., 2013). The role of this robot was to encourage users to learn how robots were made. Educational robots can be defined as social robots that are used for teaching and learning purposes. Educational robots are tagged social robots because of their interactions with human beings. Educational robots also serve as motivational and entertainment tools for research programmes. They can be used for both curricular and extra-curricular activities. Curricular activities are those that are part of the school curriculum and a formal part of the syllabus while extra-curricular activities take place after school hours at the school as workshops under the guidance of instructors, at home under the guidance of parents or at other designated locations, such as public places and events (Miller et al., 2008). Extra-curricular activities are generally more relaxed, allow for deviations and therefore easier to setup and organize.

Educational robots play two major roles which include the passive and the active roles (Mubin et al., 2013). These roles are dependent on the content to be taught, the instructor, the type of student and the nature of the learning activity. These roles include the passive role and peer or companion roles. An educational robot that takes a passive role is usually used as teaching or instructional aids. These types of robots are usually used as programming projects to demonstrate the basic concepts of programming. A typical example of this type of robot is the LEGO Mindstorms. The LEGO Mind storms is an assembly kit that contains building block pieces and a control unit which allows a student to learn how to design, program and build another robot. This helps to develop the cognitive and psychomotor skills of students. LEGO

Mind storms was designed to build children's skills and interest in Science, Technology, Engineering and Mathematics (STEM). One of the advantages of the LEGO Mind storms is that it is reusable. However, it is not interactive in nature, although it contains tutorials which help a learner to learn the basics of coding.

Educational robots used as peers or companions learn along with the students. A typical example is the Nao robot that learns English along with children. The Nao robot is as shown in Figure 1. The features of companion robots include the following:

1. Verbal interaction: Companion robots usually have a module for speech synthesis, which allow them to utter sentences and also interact with children orally. This increases the students' motivation, self-confidence and their learning capabilities (Frank, Oliver, Baptise, Jean-Louis and Jean, 2018).
2. Non-verbal communication: Companion robots have the capability to express or stimulate emotions such as fear, anger, joy and sadness though their body movement and facial expression and they also have the ability to read learners emotions.
3. Easy Accessibility: Companion robots can be easily programmed and they have a visual interface where complex behaviours can be easily programmed.
4. They are usually Humanoid in nature: Companion robots such as Nao, Saya and Pepper are humanoid in nature. This implies that they take the shape of a human being. This increases the level of social interaction and educational experience between the robot and the students.



**Fig. 1. Nao (Zlotowski et al., 2015)**

### **3.0 The Importance of Educational Robots in Children's Educational Development**

The use of educational robot is fast advancing in developed nations and this has led to the increase in the demand for robots in children's education for motivating pupils, improving motor skills, facilitating instructions, increasing pupils' interest levels as well as improving learning skills. This section therefore takes a critical look at the importance of deploying robots in education.

- a) **Educational robots can be used as therapeutic devices:** Therapy robots are robots that provide treatment for people with physical and mental challenges. For instance, researches have shown that people suffering from Autism Spectrum Disorders (ASD) responded to treatments involving robotic technology than treatments from human therapists (Diehl, Crowell, Villano, Wier, Tang and Riek, 2014). Hence, educational robots that serve as therapeutic devices can be used to aid children who have difficulty in coordinated interactions with their environment and other people. The Nao robot is usually used for this purpose.
- b) **Educational robots provide entertainment to students:** These are robots that improve the learning capabilities of children by entertaining them. Examples of entertainment provided by these types of robots include games, music and video. These types of robots are also used to develop the cognitive and affective aspects of learning. A typical example of an entertainment robot used as an education robot is the Pepper robot.
- c) Educational robots with emotional intelligence capabilities can be used to acquire relevant information from children. This information can be obtained through children's emotions such as body postures, movements, gestures, facial and vocal expressions. This information can be used to know if the concept taught by the robot is well understood by the children or not. A typical example of this type of robot is Nao.
- d) **Educational robots make learning simple:** Educational robots are mechanical devices that have the ability of repeating concepts taught without getting tired unlike a human teacher. This characteristic of educational robots increases the retention rate of students and also makes learning simple by elucidating difficult abstract concepts
- e) **Educational robots can be used as tour guides:** Educational robots can be used as tour guides in environment that an individual is not familiar with. For instance, the shakey robot and Jijo 2 robots are used

to support people navigating through an environment (Miller et al., 2013). Figure 2 shows the Jijo 2 robot providing a tour guide to an individual at the National Institute of Advanced Industrial Science and Technology.



**Fig. 2. Jijo-2 Robot giving a tour at the National Institute of Advanced Industrial Science and Technology (AIST) (Miller et al., 2013)**

#### **4.0 Challenges of Educational Robots in Children's Educational Development**

Educational robots are plagued with numerous challenges despite the benefits in education. These challenges are highlighted in this section.

- a) **Fear of Displacement:** One of the major challenges of educational robots is that students may have the feeling that their teachers have been displaced and replaced with robots.
- b) **Emotional Attachment:** Humanoid robots that looks exactly like humans and are used as teachers or tutors can create emotional attachment between children and robots. This usually creates a form of deception in the minds of the children. Thus, a loss or an irreparable damage of the robot can affect the learning process of the child.
- c) **Training:** Adequate training is required by the tutors who want to deploy educational robots as teaching aids. Hence, learners who have not been adequately trained on the use of educational robots for learning may find it difficult to use the technology for learning.

- d) **Technology Reliability:** Robots are mechanical devices that can fail at any time. Hence, the reliability and integrity of educational robots is a challenge.
- e) **Cost:** The cost of maintaining robots in education is high. Hence, educational robots are not widely deployed.
- f) **The Appearance of the robot:** An educational robot that has the same appearance with a human might create fear in the minds of the learners. This concept is referred to as uncanny valley (Iroju et al., 2017b). This may in turn impede learning.
- g) **Safety:** Some robots are designed with sharp edges which can cause lacerations and severe harm to children. This can discourage the children from learning with this form of technology.

## 5.0 Conclusion

In recent times, robots have been applied in several fields such as, Healthcare, Military, Entertainment, Communication and Education. Robots play two major roles in education. These include passive role and peer or companion roles. An educational robot that takes a passive role is usually used as a teaching aid while educational robots used as peers or companions learn along with the students. This study examines the importance and challenges of robots in education. Educational robots improve the learning capabilities of children by entertaining them; they have the ability of repeating concepts without getting tired unlike a human teacher. Hence, they increase the retention rate of students and also make learning simple by elucidating difficult abstract concepts. The fear of teachers' displacement and replacement by robots, adequate training of teachers who deploy robots as teaching aids and high cost are some of the challenges plaguing the adequate use of robots in education. This study recommends that teaching should not be totally left in the hands of robots, the appearance of an educational robot should not be too close to that of human beings in order to avoid a repulsive reaction from learners and the design of educational robots should be robust and fault tolerant in order to avoid an abrupt distortion in the learning process.

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