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# Application of Educational Gaming and Robotics in Teaching and Learning Process

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**Abstract:** The development of technology has resulted in the development of many assistive tools employed to facilitate education. Amongst these technologically enhanced tools developed for education are games and robots. This paper examines the application of educational games and robots through review of available literature. The areas of application of games and robots in education have been presented. The paper further highlights some challenges encountered in the deployment of games and robotics in education.

**Key Words: –** Creativity, Computer Simulation, Autonomy, Flexibility, Collaboration.

## 1.0 INTRODUCTION

This paper presents the application of games and robotics in education. The importance of games and robots are equally presented. The paper continues by addressing some challenges involved in the application of games and robots in education.

Games and robots are implemented in education as assistive tools to facilitate learning processes. There are varying cognitive abilities between students. This therefore, affects their learning adaptation. A wide variety of technological applications have been developed to support the students at varying levels of academic domains. Such technologies include robots, game apps and computer simulations (D'mello&Graesser, 2013).

Alcorn (2003) defined game as "kind of sports or entertainment that requires participation, competition with oneself or with other rivals to achieve certain goals and have special rules." Educational games on the other hand, are software that help students to learn lesson subjects and to develop their problem solving skills by using their desire and enthusiasm to play (Cankaya&Karamete, 2008). Games in education provide for an interactive strategy in education and are capable of developing students' skills areas such as creativity, flexibility, autonomy, collaboration and responsibility (Pontes 2013).

De Freitas (2006) noted that the learning processes are not controlled entirely by the games when applied in education.

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Learning activities such as feedbacks and reflections relate to topics treated in the games are required.

Prensky (2003) noted that young people are motivated towards games and often lack interest in educational contents. Fracer (2003) noted that this interest in games shapes their cognitive abilities and interests in learning which sometimes, make formal education meaningless to them. Prensky (2003), however, noted that the motivation in games could be combined with educational contents to further capture the interests of young people. He proposed Digital Game-Based Learning as a tool to achieving this.

Games that incorporates educational objectives and subjects are capable of making academic learning easier, enjoyable, interesting, learner-centered and more effective (Kafai, 2001). The interest in educational games could vary along gender line. This shows that gender preference could affect the use of educational games. Empirical research, however limited, on the use of games in education, showed that male and female genders prefer different kinds of game with male playing more games and for longer period than the female (McFarlane et al, 2002).

Robots are physical and autonomous artifacts with capabilities of interacting and communicating with humans through human social mechanisms such as natural speech and social cues (Brazeal, 2003). Benitti (2012) noted that robotics technology is a fashionable tool for education of students in middle and high schools. Significant development have been recorded in the design of social robots applied in education which include areas such as its anthropomorphic, morphologic and technical capabilities (Disalvo et al, 2002).

Robotics have been implemented in education in varying areas ranging from social assistive tools to advance learning tools. Some robots operate incorporating games, videos and many other mechanisms.

## 2.0 RELATED WORKS

Educational games have been developed to help health professionals to acquire skills necessary to perform professional task as developed by Andrew (2011). Hou& Chou (2012) developed digital game that supported physics students to learn complex topics such as electromagnetism.
Pontes et al (2020) developed an educational, turn-based, cross-platform, visual-based and touch-ready digital game that helped teach children and adults how to learn signs in Brazilian Sign Language (BSL). The game, MatLIBRAS promotes the deaf culture and is capable of using other sign language other than the Brazilian sign language.

The learning effectiveness and motivational appeal of computer based game on the learning of computer memory concepts was examined by Papatergiou (2009). The game based learning application was designed in accordance with Greek high school computer science curriculum. This study was done in comparison with a similar application having similar content but lacking the game aspect. Result obtained showed that gaming approach was more effective than the non-game approach in the promotion of student's knowledge in computer memory concepts. The researchers furthermore, recommended the use of computer games for the motivation of students in learning.

The effectiveness of educational game in the improvement of arithmetic skill in children was examined by Casteller et al (2014). The results obtained showed that the use of games for arithmetic is beneficial for both cognitive and affective learning outcomes.

A social assistive robot, KindSAR was developed by Friden (2014) for the education of preschool children. The tool was developed to provide assistance to teachers by engaging kids through educational games by storytelling. In its application, the teacher is provided with detailed feedback on the children's performance with game task. The tool showed unique results as it was capable of facilitating constructive learning through storytelling and teaching of new motor skills and concepts. The development of KindSAR however, contrast the position of Benitti (2012) that posited that robotics in education is applied to teaching children in middle and high school.

Chang et al (2010) in their investigative study on the influence of robots on authentic learning experience of students, designed a mixed-reality based robot, RoboStage to ease authentic learning amongst junior high school children. Results obtained from experiment showed that the use of RoboStage significantly improved the sense of authenticity of the task performed by students and positively affected learning motivation of the students in learning.

Chen et al (2020) developed a novel bi-directional child-agent peer learning robot that compared the impacts of tutor, tutee and peer agents on the learning and affect of children. Fifty-nine children between ages 5 – 7 were used in the study. Results of the study revealed that the children's vocabulary were improved while using the robot as a tutor and a greater affect was exhibited by the children when the robot served as their tutee. Therefore, both cognitive and emotional needs of the students were improved with the use of robot as a peer agent.

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## 3.0 APPLICATIONS OF GAMES AND ROBOTICS IN EDUCATION

The application of robots have grown from fields to fields. Earlier applications of robots were in industrial manufacturing and lacked humanoid features. Recently, the application of robots have been seen in various domains including education (Breazeal, 2014).

Robotic application in education aids in improving problem solving, logic and scientific inquiry (Friden, 2014). Robots application in education serve as IntelligentTutoring System (ITS). ITS is a field with use of computer for instructions, feedback and students guides (D'mello&Graesser, 2013). ITS is capable of assessing students' mastery of knowledge as noted by Baker et al (2010),modelling of students cognitive states (Cobett et al, 2010), patterning or adapting the learning contents to individual needs as noted by Manickam (2017) and also capable of capturing students affect and motivations (D'mello&Graesser, 2013).

Social assistive robots have been applied in the education of people with special needs/vulnerable people. Heerink et al (2008) noted that social assistive robots have been implemented in the education of elderly patients while Shukla-Mehta et al (2011) noted their application in teaching children with autism. Also, social assistive robotics have been implemented in child care and studies have shown its positive impact on the development of children with social disorders (Kozima et al, 2004; Tanaka et al, 2006).

Gordon et al (2016) and Kory-Westlund (2019) from their works, noted that social robots are capable of eliciting rich social behaviour from students and enhance their engagement and learning due to its attentive and expressive co-present behaviours. Many social assistive robots such as KindSAR developed by Friden (2014) are capable of regulating and monitoring the cognitive development of children over time and provide unique data on children's performance to aid teachers' evaluation.

Social robots have helped students learn various skills through gaming (Movellan et al, 2009). Also, social robots have been applied as a tutee where it is used to interact with students as a learner (Chin et al, 2013). In this approach, the robot is useful in the estimation of the students' abilities and helps in the personalization of students' learning content appropriate to the student knowledge level (Park & Howard, 2015). Tanaka &Matsuzoe (2012) however, noted that the use of social robots as tutee without involvement of a human teacher to instruct may hinder students learning especially children. Further application of social robots has been applied in reciprocal peer interaction (Howard et al, 2017; Ros et al, 2016).

Educaitonal games are implemented to motivate students' interests in learning activities of students. Games enhances the affective appeal of students towards learning as presented by Papatergiou (2009). Also, games have been developed to improve the skills of students in their curricula contents. Educational games have been implemented to improve arithmetic skills of students, improve their memory in learning complex subjects in science, technology, engineering and medicine.Important concepts such as algorithms, programming and data structure could be learnt by application of digital games.

Kolb (1984) noted that educational games are developed to make students active in learning, reflect on their performance by considering their weaknesses and strength and develop plan for their future actions. Educational gaming allows for large volume of materials to be covered within a single activity(Boctor, 2013).

Digital games have been employed to teach students with disabilities. Pontes et al (2020) developed a game capable of teaching students that were deaf the Brazilian Sign Language. The game was also capable of incorporating other sign languages.

## 4.0 CHALLENGES IN THE USE OF EDUCATIONAL GAMES AND ROBOTS

Despite the huge capabilities shown by robotics in education in the facilitation of teaching and learning, research have shown that the use of robots in education remains insufficient. This is hugely affected by the acceptance of the technology by teachers. Buabeng-Andoh (2012) however, noted that the acceptance of the use of robots in education is affected by factors such as user characteristics, content characteristics, technological considerations and organizational capacities.

Friden&Belokopytov (2014) carried out a methodical research in the acceptance of socially assistive robotby preschool and elementary school teachers in a workshop they organized. From the study, a positive acceptance was demonstrated by the participants of the workshop towards social assistive robots. This acceptance was due to the level of exposure of the participants of the workshop. In other settings, a less positive acceptance was observed.

The use of robot in education is faced with a challenge of breakdown in interaction between robots and their users. Serholt (2018) in her study investigating the causes of breakdown in the interaction between children and robotic tutor, revealed that the likely causes could be due to any of

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the following four reasons; lack of consistency and fairness, robots inability to evoke initial engagement and identify misunderstanding, confusing scaffolding and problems with control.

Tusan et al (2008) highlighted that some disadvantages exist in the use of games in education despite huge advantages it presents. In their work, they argued that the use of games in education requires heavy investment, orientation process, more time than the traditional method of learning and could cause the students to spend more time with game activities other than educational purposes.

The challenges presented above could be mitigated through improved design of games and robots. The design of robots should consider aspect that engages the users properly to avoid breakdown. Also, the incorporation of games into learning should be used such as it could not consume more of the affect and time of users.

## 5.0 CONCLUSION/ FUTURE FRAMEWORK

This paper examined from literature the application of games and robots in education. In the paper, games and robots have been revealed to be great assistive educational tools that have been deployed in various areas of education. From the paper, educational games and robots have been revealed to be capable to;

- Capture students affect and motivation to learning and make students active in learning.
- Improve the problem solving skills of students.
- Assessment of students' knowledge and model their cognitive states.
- Education of both elderly and young learners.

However, the incorporation of games and robotics in education is posed with some challenges. The literature examined in this paper revealed that the use of robot and games in education is posed requires heavy investment and is time consuming. Also, the deployment of robot could result in breakdown in interaction between the robots and their users. The use of robotics in education has not been generally accepted.To overcome the above mentioned challenges, it is highlighted in the paper the use of optimized design of specific games and robots to addressing the challenge.

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