Educational Robotics in Smart Learning

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EXECUTIVE SUMMARY

Science, technology, engineering, and mathematics (STEM) are the key courses for the students in the 21st century. There are several teaching approaches to improve the average scores in STEM education. Involvement of robots in the teaching-learning process plays an important role to transform and enhance the learning process. The technological advancement helps the students to translate the typical mathematics and science concept into real-word applications. In this chapter, some concepts of STEM have been implemented with the help of Bioloid educational robots. The educational robotics enhance the academic achievement of the students. The programming of the BioLoid robots is carried out using RoboPlus software, and the outcomes of the concrete mathematics concepts are shown physically.

INTRODUCTION

Among the technological advancements in the field of education, robotics is making an important difference in the teaching-learning process (Ruzzenente, Koo, Nielsen, Grespan, & Fiorini, 2012). The educational robot is considered as an interactive, complementary tool to enhance students' motivation, particularly for learning and understanding abstract concepts of STEM (Science, Technology, Engineering and Mathematics). The robot is helping students and instructors in the learning process, as well as in improving cost and time effectiveness. There are however some issues that should be addressed for the effective utilization of robots in education, for example maintaining students'interest, high cost of robot kits, devising effective lesson plans and inadequate time and training of the teacher (Mataric, Koenig, Feil-Seifer,2007, Park & Han, 2016). Learning through technology also depends on carefully designed course materials. One should identify the need of technology for effective delivery to achieve learning outcomes of the topic and course. Since the nature of the class varies from student to student, then the

course materials should be designed to meet the requirements of the students. In this regard, it is useful to note that the mathematics component of STEM appears in robotics in everything from taking the measurement of a robot and all its various pieces to calculating the amount of current necessary to charge it. As such, there are many applications of mathematics necessary to build a robot and make it work.

This case study deals with using the education robot Bioloid to incorporate STEM concepts for smart learning of mathematics. It looks at the Calculus course offered to undergraduate students at the College of Computer and Information Sciences, Kingdom of Saudi Arabia to explain how educational robotics helps students to understand and gain more knowledge in their course.

The objectives of using robotics in education are to:

1. Review basic concepts of mathematics;
2. Provide an innovative introduction to the topics;
3. Prepare strategies to present the topics as required by the course;
4. Enhance the learning capabilities of students;
5. Help students understand the ways to communicate with the machine and resolve concrete problems in mathematics;
6. Encourage the students to learn about building robots.

LITERATURE REVIEW

Robotics literature spans many decades of research. In this section, research on the use of educational robotics will be discussed.

Thein, Terracina, Iocchi &Mecella (2016) have conducted an experimental study on the use of robotics as teaching assistants. Their study involved two groups of students, one using robots and another using traditional teaching methods without any robotic assistance to solve the "Tower of Hanoi" problem. Their findings show significant difference in learning effectiveness between the two groups of learners, with the group that was assisted by robots performing better that their peers who used traditional teaching methods. For example, the students using robots were able to answer 15% more questions, and demonstrated 12% more involvement in class and higher comprehension by 11.2%. The findings of this study suggest that experimental activities are important in the design and development of educational robotics and optimality of various teaching methods need to be explored to ensure steep growth in achieving learning outcomes. Educational robotics have been noted for helping to make the classroom more interactive for teaching courses in STEM (Barak & Assal, 2016). In their study, Park & Han (2016) have discussed the factor of technological acceptance by examining teachers' views on the use of robot and cloud services. Among their findings are that tele-operated robots are effective in terms of cost and for delivering verbal and non-verbal messages.

Other studies highlight that robotics provide only specific knowledge to learners of mathematics, science and programming(Awad, Barak, 2014; McCormick, 2004; Voustina, 2012), whereby it covers only limited knowledge and cognitive skills. Hence, well-trained teachers and a clear set of course instructions are vital for ensuring effective outcomes in the teaching of STEM(Radloff & Guzey, 2016).

Rafael Ramon-Vigo, Higueras, Caballero & Merino (2016) have used the Gaussian Matrix Model to discuss the relationship between the features of a robot and navigational tasks in the teaching of autistic

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