EDUCATION 4.0: TRENDS AND FUTURE PERSPECTIVES IN STEM TEACHING AND LEARNING THROUGH ROBOTICS COMPETITION

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ABSTRACT – *Education 4.0 is the vision for the future of education, responds to the needs of "industry 4.0" or the fourth industrial revolution, where man and machine align to enable new possibilities. This paper describes the survey results from an annual robotics competition for students in secondary schools that aims at increasing their interest towards science, technology, engineering, and mathematics (STEM). To bring the experience of Project-based Learning into robotics education by using a competition, a new framework namely Robotics Competition-based Learning (R-CBL) is proposed. The new framework, which is referred as R-CBL, provides educators with an alternative solution to overcome many of student's deficiencies associated with traditional learning practices; such as lack of motivation, lack of self-esteem, insufficient practical and real-life experience, and inadequate team work practices. S-STEM Survey is used to measure the students' attitudes toward STEM in National Robotics Competition (NRC) year 2017. To acquire the data, students are surveyed before and after the competition to study their interest towards STEM. Results indicate that students who participated in the robotic competition had a more positive attitude toward STEM subjects and related careers. Implications of results on students' attitude are discussed.*

1. INTRODUCTION

The future of the education is a new vision the or learning, starting right now. The impact of Industry 4.0 is Around 10-50% of jobs are 'vulnerable' to digitalization, but for many jobs it might be that only certain tasks will be automated – especially repetitive job routines in production, the service sector and office work. Robotics is a great agent to promote integrated STEM education [1]–[4]. In recent years, educators have been progressively making effort toward improving STEM education from primary to tertiary levels of education, but obstacles from different ways exist to challenge the implementation of robotics in education. Due to the global crisis of shortage of student interest in STEM education, increased attention has been given to the appeal and attraction of Robotics. In 21st century learning environment, robotics can easily be used to introduce a variety of scientific process skills which are needed to pursue a variety of STEM career paths [5]–[7]. Through these roles, robotics has served to interest students in science and engineering, to introduce them to real-world interdisciplinary applications, and to stimulate their intellectual development [8]. Educational robotics have

demonstrated the learning theories of constructivism, constructionism and active learning, by increasing student engagement through hands-on application in skills such as computer programming and engineering design [9]. Educational robotics for STEM is such an interdisciplinary environment which involves an understanding of related but different domains and involves participants from industry, academia and organizers of educational activities [10], [11]. Robotics competitions are widely recognized as effective motivational and organizational frameworks for robotics research and project-based learning [1], [12]. Robotics competition provide a fertile environment for robotics researchers to develop and test robots that can solve realworld problems. Competition-based Learning proposed in this study can provide an inherent framework for evaluating the benefits of using robotics in education. Past approaches by including robotics competitions in the classroom have confirmed the value of robotics in existing curriculum as intellectual development such as excitement in STEM education [1], [13], [14], building self-efficacy [15], and introduction to real-world interdisciplinary applications [16].

2. METHODOLOGY

This study aimed to assess how robotic competitions improve students' science, technology, engineering, and math interest. To prove the unique benefit of interdisciplinary robotic competition, we need measurable data that quantifies the student's experiences.
The state level NRC is held in 16 states to select the best 2 teams for each category before they participate in the national level. In the national level, total of 501 secondary school students participate in NRC 2017, however, there are only 215 students in NRC participated in this survey voluntary. The experimental group included a total of 193 males and 22 females with an average age of 15.6 years. The control group contained 35 males and 25 females. Participants self-reported their gender, age, grade, and race. After 2-8 weeks gap varied by the different states, the voluntary students again filled out the survey on the day of national level NRC, and gave it to their teachers after the competition. The questionnaire and its administration were approved by the organizers which are Ministry of Education Malaysia (MOE) and Sasbadi Holdings Berhad. For the control group, we found teachers to distribute the survey during the same period as the participants in National Robotics Competition to take the survey.

3. RESULT AND DISCUSSION

A preliminary analysis evaluation the homogeneity of-slopes assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable, $F(1, 95) = 1.25$, $MSE = 40.92$, $p = .27$, partial $\eta 2 = .01$. Therefore, the homogeneity of slopes test indicated that the assumption had been met and that the results of an ANCOVA would be meaningful. A comparison of the pre- and post- means indicated that students who participated in the NRC had a more positive attitude toward the adoption of STEM attitudes than students who did not participate in NRC. Students in the NRC group had statistically significantly higher attitude means, ($p < 0.05$), than students in the comparison group measured by the S-STEM survey.

4. CONCLUSION

Education 4.0 is aimed to establish a blueprint for the future of learning, which is a lifelong learning, from childhood schooling, to continuous learning in the workplace, to learning to play a better role in society. Technology has become integrated into virtually every aspect of work. This paper presented a new learning model, namely, the R-CBL model that combines PBL and competitions. In conclusion, design competitions can effectively be integrated into coursework with well-planned learning outcomes. The S-STEM surveys used in this study are robust instruments that secondary school STEM education program leaders can use to understand students' psychological states and the impact programs may have on student attitudes toward STEM disciplines and 21st century skills and interest in STEM careers. This framework is still somewhat new, and researchers are encouraged to continue testing and refining the limitation and to overcome the obstacles in the future study. As summary, the unique features of this framework used in include: (i)Achieves Project Based Learning through a competition. (ii) Provides opportunities to talented students to work hands on with a robot. (ii) Leverages the competition to motivate students to pursue STEM careers in the future.

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