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An Investigation of Vocational Students' Attitude towards STEM Robotic Activities

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Abstract: Engineering education is one of the most demanded topics in Thailand. With the traditional instruction, pre-service engineering teachers are not well promoted to learn actively. Based on this point of view, this study developed a series of active learning activities in corresponding to the Robotic based on STEM framework. This aims to help enhance students' understanding on the robotics, functionality, and applications. This study documented perceptions of STEM (science, technology, engineering and mathematics) content and careers for vocational students participating in STEM activities focused on industrial robotics. The analysis of the answers from 578 students in vocational education attended the activities and completed the questionnaires that showed the results showed that student's attitude after the activities were compared across gender groups (men=421, female=157). The finding of this study is not only fruitful for students, especially pre-service engineering teachers, but also shed light of the revolutionized teaching activities for other teachers in different fields. Since this is a very first implementation of the proposed framework, it requires more investigations and improvements in the future.

Keywords: STEM Robotics, vocational education, pre-service engineering teacher, engineering education

1. Introduction

The enhancement of effective vocational students has been a focus within the education system. One approach towards increasing engagement with STEM (science, technology, engineering and mathematics) is through the use of robotics in education. Robotic can acquire a students' imagination like no other learning materials by creating learning process to enjoy activities (Chookaew et al., 2018). Consequently, the students can learn programming via robot's behavior in various sequences and using intuitive, visual programming on a computer screen or other device (Ortiz, Franco, Garau, & Martin, 2016; Witherspoon, Higashi, Schunn, Baehr, & Shoop, 2017). Robotics based learning is considered as a powerful tool for motivating and training students based on STEM curriculum; therefore many studies and experiences that have been developed around the world over recent years (Castro et al., 2018; Spolaôr & Benitti, 2017; Witherspoon et al., 2017). Additionally, many studies proposed robotic to support students' performance with engineering process by industrial need (Vitale, Bonarini, Matteucci, & Bascetta, 2016). However, there is still no study on a robotic based STEM framework for the vocational students, especially their attitudes towards using the industrial robots that may impact the success of learning process.

In response, our activities use active learning to foster a range of important skills across the core STEM subjects. Finally, our study investigated the students' attitude toward STEM Robotic activities. This study was guided by the question:

- How does the STEM robotics activity influence vocational students' attitude?
- What are student learning perceptions on the STEM robotics activities?

2. Related Study

2.1 STEM Robotic

The current research has been interested using robotic for learning in science, technology, engineering, and mathematics (STEM). Many educators approach work with students through STEM robotics activity that provides a very abundance and attractive learning environment and influence on students' motivation about learning science and technology for STEM education (Barak & Assal, 2018), while some study proposed the practical ways to help teachers how to design and implement STEM concept using robotics activity to enhance student learning (Jaipal-Jamani & Angeli, 2017; Kim et al., 2015).

Researchers have attempted to use the benefit of robotic in order to motivate the inspiring vocational students to interest between STEM learning, real life and industry. An articulated robot and mobile robot were used to illustrate the work for vocational students because they are most commonly in use in factories worldwide. Therefore, the vocational students should know and understand related that use in an industrial system.

2.2 Vocational education in Thailand

Thailand education system has been formal vocational and technical education is conducted at three levels: upper secondary, post-secondary (a diploma or vocational associate degree) and university level (degree). The government of Thailand has been endeavoring to enhance vocational students' performance with reforms are currently being implemented to remodel the system towards a Thai vocational qualification based upon industrial practices and needs. There for the big project is the Eastern Economic Corridor (EEC) that focused on improving vocational educational measures to help curb the skilled labor shortages three eastern provinces where the EEC project is located including Rayong, Chonburi, and Chachoengsao (https://www.eeco.or.th/en). Thailand has been using robotics and automation technology and existed large-scale mass production systems. Thus, robotics and automation are important topic to learn for vocational student.

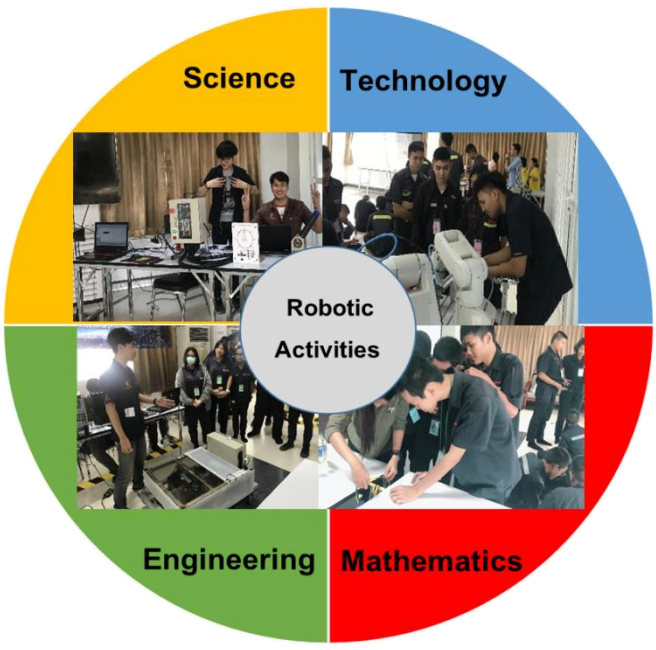

Figure 1. An Overall Structure of STEM robotic activities

3. Methodology

3.1 Participants

Participants in this study were 578 vocational students who were studying diploma program at vocational colleges in three eastern provinces of Thailand where the EEC project is located including Rayong, Chonburi, and Chachoengsao provinces. Among them, 157 vocational students were females and 521 students were males. They ranged in age from 18 to 21. Students attended "Preparing students' performance of STEM robotic toward EEC Project" for one day (7 hours).

3.2 Instrumentation

In this study, we used an online questionnaire to assess students' attitude toward STEM Robotic activities. The questionnaire includes four dimensions (engagement, motivation, awareness, and satisfaction), a total of 12 items. Internal consistency reliabilities for the five scales of the STEM Robotic attitude survey was 0.927.

3.3 Experimental Procedure

In this study we develop the learning activities with Robotic based on STEM framework. The activities focus on promoting students' understanding through active learning consisting of 4 sections:

Section 1 Basic of Robot: This section has explained a servo motor that is a rotary actuator that allows for precise control of angular position, velocity and acceleration in many places such model car robots. This section focusses on students' understanding of how a servo motor works and is applied in the robot. They have described via presentation with concept map, see Figure1 (a).

Section 2 Mobile Robot: Mobile robots have the capability to move and remove belongings. In addition, robot shown the performance of detect and automatically avoid obstacles, see Figure1 (b).

Section 3 Robot Arm: This section has showed an articulated robot system that used in an automotive industry robotics, especially welding robots. This type of robot is the number one imported robot in ASEAN region, see Figure1 (c).

Section 4 STEM Connection: This section has showed the activities for connecting between science and mathematics subject to create technology and engineering work. The proposed activities can help improve students' understanding on the relationship between force, mass, and acceleration, see Figure 1 (d).

(a) (b)

(c) (d)

Figure 2. The learning activities each section

4. Results

In order to analyze data how vocational students' attitude towards STEM robotic activities, we have described the gender gap in science, technology, engineering, and math (STEM) engagement is significantly larger in technological fields (Master et al., 2017). Paired sample t-tests was used to analyze the difference vocational students' attitude between men and female that shown in Table 1.

Table 1

The questionnaire

Items	Male = 421	Female = 157	*t*	*p*
	M ±SD	M ±SD		
Motivation				
Q1: I like to engage in STEM robotic activities.	4.22±0.90	4.04±0.84	2.07	0.03*
Q2: I am interested to learn related STEM subject more.	4.27±0.81	4.07±0.77	2.65	0.00*
Q3: I understand about STEM Robot activities.	4.31±0.80	4.06±0.74	3.37	0.00*
Q4: I think STEM Robot activity make your inspiration to study related Science and Engineering.	4.32±0.82	4.29±0.76	0.33	0.73
Q5: I want to learn in deep concept related Science, Technology, Engineering and Mathematics more.	4.28±0.82	4.17±0.77	1.53	0.12
Awareness				
Q6: I would like to be scientist or engineer in the future.	4.12±0.89	4.01±0.90	1.26	0.20
Q7: I think that everything is Science, Technology, Engineering and Mathematics.	4.26±0.82	4.17±0.84	1.12	0.25
Q8: I can connect the Science Mathematics subject to create Technology and Engineering.	4.11±0.89	3.91±0.88	2.41	0.01*
Q9: I aware that Science, Technology, Engineering and Mathematics are the part of important daily routine.	4.24±0.81	4.07±0.79	2.25	0.02
Satisfaction				
Q10: I enjoy learning Science, Technology, Engineering and Mathematics.	4.28±0.85	4.15±0.86	1.53	0.12
Q11: I am satisfied with STEM robotic activities.	4.38±0.79	4.25±0.82	1.64	0.10
Q12: I would like to participate another STEM robotic activities.	4.36±0.81	4.24±0.81	1.64	0.09

*$p<0.05$

Based on this result, it can be implied that the proposed STEM robotic activities for vocational students.

5. Conclusion

With the drawbacks of traditional engineering education, this study developed a series of active learning activities to help promote pre-service engineering teachers' understanding by incorporating with Robotic based on STEM framework. This is to help students be readier and more comprehensive of how the robotics work and how they can be applied in the real industries. After experiencing four sections of the proposed learning activities, students both male and female have revealed positive attitudes toward the proposed learning framework on different dimensions, including learning motivation, awareness, and satisfaction.

However, based on this very first implementation of the proposed Robotic based on STEM framework, it still remains some limitations that can be further improved in the future, also requires more investigations. For example, the activities can be provided differently to different groups of learners based on their learning performance or learning interest. Besides, there should be a guideline for the teachers to follow as a learning facilitator. This can significantly boost the learning environment

more fruitful and lively; in the meantime, they can naturally understand the learning phenomena both positive and negative in order to improve later. Regarding the finding of this study, it has a generalization issue due to the implementation on the certain group of samples. In the future, a comparison study between groups of samples, experiments or interventions can enhance the impact of this finding. Several recommendations for applying robotic activity are presented. The teachers are required to put more teaching effort on engaging students in the hands-on activity that can increase their attention and learning experiences; furthermore, these tasks can help enhance positive attitude for all students.

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