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Design the Collaborative Robot Training for Preparing the Vocational Teacher Professional Development

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Abstract: Technology is rapidly changing. No matter how good learning for teachers is, it cannot be expected to prepare teachers for all the challenges they will face throughout their careers. Therefore, they must receive the preparation for teaching the student-related using technology continuously. This paper reports training courses for teachers in Technical and Vocational Education and Training (TVET) in Thailand. This course was designed for the vocational teacher to teach industrial robots based on new technology integrated new pedagogies. The 3P module of the training process included preparing industrial collaborative robots (Cobot) concepts, practicing the learning pedagogies, and presenting the teaching process. This course provides vocational teachers opportunities to participate in the activities for four days. The results showed that teachers' teachers' satisfaction towards training courses. It is expected that this study will provide more understanding about nature industrial robot training in Thailand.

Keywords: Vocational education, professional development, educational robot

1. Introduction

The Thai government's National Strategy Thailand 4.0 is guiding the development of the Technical and Vocational Education and Training (TVET) curriculum. TVET will significantly contribute to high-value services by educating unskilled and low-skill labor with knowledge and high skills following the government's policy. In driving vocational education management and improving Thailand's vocational education quality upgrade the quality of TVET teachers with upskills/reskills personnel training.

The Robot Institute of America uses the definition that a robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through variable programmed motions to perform various tasks (Wallén, 2008). Robots are essentially a mechanism are operating under computer control and widely used in industries. They are becoming more effective-faster, more accurate, and more flexible. They become able to do more and more tasks that might be dangerous or impossible for human workers to perform.

The use of industrial robotics in the industry has expanded significantly over the past decade. Many colleges open the course or cuticular of industrial robots in manufactory. It is emphasized, especially in Technical and Vocational Education and Training (TVET), because industrial robots are widely used in many manufacturing industries, increasing career prospects for vocational students who

graduated. The training workshop described in this paper was implemented for TVET teachers at different schools working in many Thailand regions.

Industrial robots are also important for tasks where the environment is harmful to humans. Therefore, the robots need to be service-able, have high precision, operate at high speeds, and be robust to disturbances (Fonseca & Freitas, 2018). An industrial robot's complexity of the theoretical concepts required makes this discipline difficult for students to get deep understanding while teachers difficult to find out learning strategy to teach with classical teaching methods. Many studies attempted to present methodology and simulation tools based on active learning for industrial robotic education (Lopez, Romeo & Guerrero, 2009). Many studies proposed training courses or cubiculum for teachers to effectively teach industrial, educational robotics based on pedagogical insights and hands-on activities (Castro et al., 2018; Sergeyev et al., 2017). Some teacher training courses have more than just building and programming robots and expected teachers able to build on the educational benefits of robotics for providing a learning landscape that fosters many skills for learners (Alimisis, 2019).

This study focuses on designing and implementing training courses where TVET teachers can apply industrial robots to teach in their colleges. During this, we survey the teachers' satisfaction towards training courses that expected this study to provide the teacher more understanding about pedagogies for student learning.

2. Related Work

2.1 Technical and Vocational Education and Training (TVET) in Thailand

In Thailand, Technical and Vocational Education and Training (TVET) is an essential part of the education system to develop workers' skills follow the industrial system's need. TVET colleges continue to struggle to fulfill their mandate of skills development among students who will be good workers. Therefore, professional teacher development is the first important thing for operating to succeed in the goal. Many studies attempt to prepare professional training for TVET teachers who wish to advance or acquire new professional skills. (Ahmed & Syed, 2021).
Chookaew et al. (2021) investigated the TVET teachers' perceptions of Thailand's industrial robotic training course. They find that the teachers have never used an industrial robot for teaching purposes, which is an obstacle to effectively teaching industrial robot concepts. Therefore, it is challenging to learn new technology, so the course must be exciting and easier to understand. Because the teachers are interested in the topic, they will be motivated to try hard or remember what they have learned.

2.2 Collaborative Robot (Cobot)

The collaborative robot (Cobot) is developed purposely for performing manufacturing tasks. Comparing to a traditional industrial robot, the Cobot can sense the interactive force between device and surrounded environment by using embedded joint torque sensors. With this feature, the robot can be reprogrammed to compliance or suddenly stop when the collision is detected. Thus, the Cobot can reduce the incidence of occupational risks among the employees, increase their safety and also improve the performance of the entire assembly line in the industry. The collaborative robot frees employees from potential occupational risk and the cobot implemented better assembly line performance (Realyvásquez et al., 2019).

In this training, we used the Cobot UR5 model from universal robot©. This robot arm is lightweight 6-DOF manipulator which can be installed on the top of movable table. In this configuration, it is flexible to be built directly inside machinery or in other tight workspaces. (https://www.universal-robots.com/products/ur5-robot/).

3. Methodology

3.1 Participants

Participants were 40 vocational teachers (5 females and 35 male) recruited from Technical and Vocational Education and Training (TVET) colleges in eastern regions of Thailand. The workshop training was aimed to prepare vocational teachers to integrate industrial robots for teaching in the classroom. The age range of the teachers involved in the course was 22–65 years old. The three-day cobot training course consists of 18 hours, including theory and hands-on activity. The learning activity in this course consists of 3 modules, as shown in Figure 1.

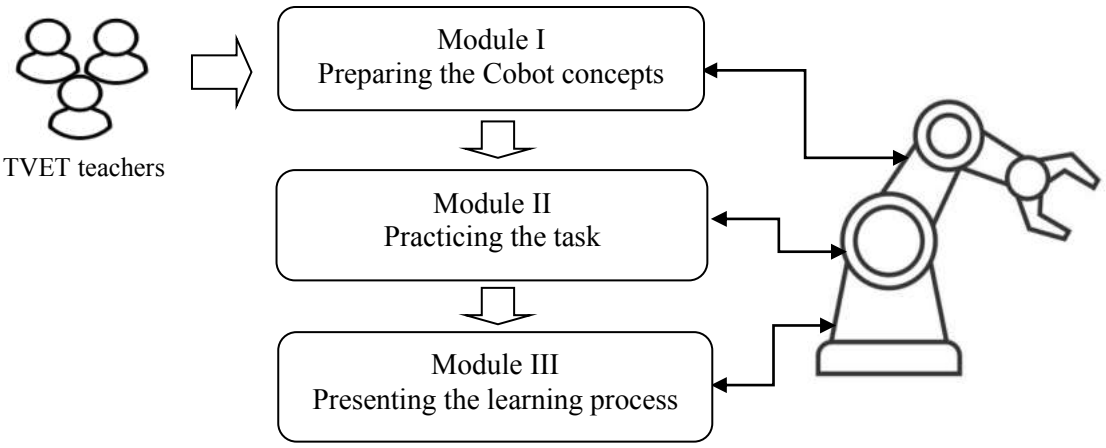

Figure 1. The structure of 3P modules on the Cobot training

3.2 Cobot Training Course

In this training course, we have three training modules of a course in three days as follow:

Module I: Preparing the Cobot concepts.

In the first step, the TVET teachers were required to understand the principles of Cobot clearly. They must understand the related to robotics and programming language that is necessary to control the industrial robot. In addition, they can develop and improve the principles of kinematics, dynamics, control, and how to optimize the conditions of the industrial robotic systems, solve problems in a factory installation and maintain industrial robots in a manufacturing facility. Firstly, the industrial robot was introduced in several types: articulated or robot arm, Selective Compliance Articulated Robot Arm (SCARA), Cartesian and delta or parallel types. Each type has a different configuration suitable for applications such as pick and place, arc and spot welding, inspection, etc. The definition and application of Cobot were also introduced in this section.

Figure 2. The introduction of the Cobot learning

This section introduces learning content and tools, including structure and components of Cobot, configuration robot installation such as Tool Center Point (TCP), mounting and HOME configuration after the robot gripper is installed, robot programming as shown in Figure 3, and simulation.

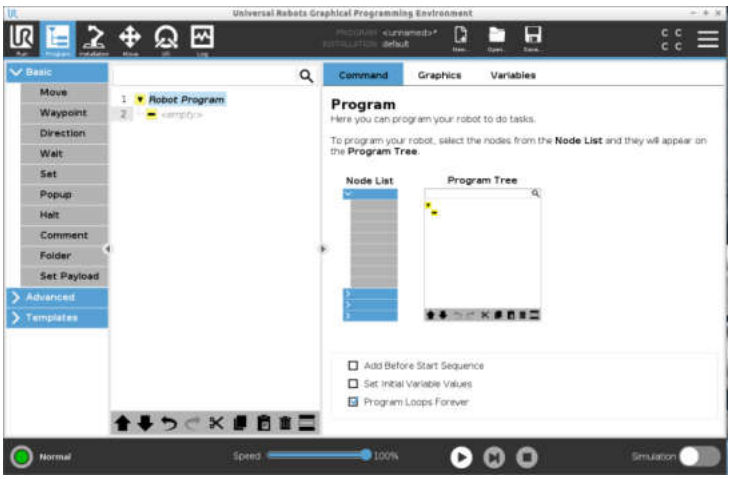

Figure 3. The screenshot of robot programming

Module II: Practicing the tasks

The TVET teacher is usually teaching robotics to students who have never had any experience in this field. It challenges teachers to define appropriate learning pedagogies to help students overcome their learning barriers. This module must select appropriate teaching and learning pedagogy and industrial applications to support students' work readiness and 21st-century skills.

This module demonstrates that it is important to combine theory and practice and include fun tasks that intertwine the challenges of applying theory to the problem-solving of TVET teachers. In this process, they were divided into groups consisting of five people in order to discuss and practices the tasks. Each group is given a specific task to complete. For example, they have learned how teach Cobot to grasp and moving small and medium-sized workpieces. Using Cobot, each member can drag the end-effector in different types of motion such as free motion or planar motion or orientation so that it is easy to reach each waypoint to grasp, travel, and place the object, respectively. After that, they will demonstrate their tasks in every group and discussion together.

Figure 4. The TVET teachers were working together during the task assignment.

Module III: Presenting the learning process

By given assignments, the vocational teachers can share knowledge and work together with the presentation in graphical programming and robot demonstration, as shown in Figure 4. The content is related to how the cobot picks up the bottle with the robot gripper and places it on the table at a specific

point. Each group can choose their picking and placing points within the robot workspace. Also, they are allowed to design the robot path and movement in order to enhance creativity.

Figure 4. The TVET teachers expanded and displayed the cobot working.

4. Results

This section presents the results of TVET teachers' satisfaction with the cobot training (Table 1). In addition, findings from the interviews are presented participants' opinions.

Table 1

The results of TVET teachers' satisfaction towards the cobot training

Items	M	SD	Interpretation
Satisfaction with the training process	4.58	0.56	Highest
Satisfaction with the training activities	4.55	0.62	Highest
Satisfaction with the usefulness of the training workshop	4.62	0.49	Highest
Overall	4.58	0.53	Highest

Table 1 shows three dimensions of TVET teachers' satisfaction towards the cobot training, including the training process, the activities, and its usefulness. The results show that the TVET teachers were satisfied at the highest level about the training course overall (M=4.58, SD=0.53). They expressed the highest level of satisfaction about the usefulness of the training (M=4.62, SD=0.49) while the training process (M=4.58, SD=0.56) and the training activities (M=4.55, SD=0.49) were also thought to be at the highest level.

In addition, we have interviewed the teachers who participated in the training course:

"I prefer to learn with cobot thought active learning activity. However, when I come back to my classroom, I do not have a cobot for teaching because it is expensive to provide for my students." (Female aged 25)

"I disliked mistakes in the programming to control cobot. However, I think simulation in the program helped me to understand the mechanism and moves the robot arm to desired waypoints or touch the arrow keys on the easy-to-use touchscreen tablet." (Male aged 43)

"Everything in the training course made me learn about robot tasks; it has allowed me to be flexible and challenge. I think that professional development can adapt the learning experience to many different situations is more important than many pedagogies but lacks connecting. (Male aged 37)

5. Conclusion

Teacher roles are changing due to new approaches to learning, with growing attention to new technology and new pedagogies. With the teacher becoming a facilitator of learning processes, they should be expert knowledge transfer to students. This study reports on the collaborative robots training

course for TVET teachers that enables them to be master the technical and pedagogical skills necessary for using the robotic technologies in their colleges. In addition, this training enriches their teaching and learning activities and develops their robotics activities through innovative pedagogies. Cobot training has become a unique learning tool that arouses teachers' curiosity and motivation to learn new technology material that supports hands-on practice in an active learning activity.

This study suggested the educator relevant parties to ensure that the proposed policies and strategies will produce the qualitative learning course production and improvement of skilled TVET teachers in Thailand.

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