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Applying Outcomes-Based Learning in Mechatronics and Robotics Program: Case Study of Singburi Technical College

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Abstract: Thailand is a growing country in terms of both the number of workers and its economic expansion. However, Thailand's workers may bey have specific skills in the profession, below the expectations of entrepreneurs. Therefore, the needs for skilled workers in vocational education are a national plan of the office of the Vocational Education Commission. To produce and develop the workforce in professional, skill level, technical and technological levels, including vocational training to enhance knowledge and vocational skills training to improve the labor market in the industry. In this study, we have developed a curriculum design cooperating with the establishment in an industry with applying outcomes-based learning approach for students in Mechatronics and Robotics program. It focuses on managing each course to create pieces that correspond to industrial skills, especially manufacturing. Provide students opportunities to develop skills solutions, joint operation, communication, build self-confidence and create a positive learning outcome.

Keywords: Outcomes-based learning, vocational education, project-based learning

1. Introduction

Nowadays, the robot market in Thailand is growing in demand and an overall number of users. Automation and robotics are critical industrial variables in industrial, especially manufacturing, with automation requirements and increasing industrial robots. However, Thailand's current labor situation in the industrial sector is essential for investors worldwide interested in Thailand's business. Owing, Thailand's workers may bey have specific skills in the profession, below the expectations of entrepreneurs. Therefore, the needs for skilled workers in vocational education are a national plan of the office of the Vocational Education Commission. To produce and develop the workforce in professional, skill level, technical and technological levels, including vocational training to enhance knowledge and vocational skills training to improve the labor market in the industry (Office of the Vocational Education Commission, 2017). Based on Thailand Vocational Education Qualifications Criteria, covering four dimensions consisting of 1) the aspect of morality, ethics, professional ethics, good attitude, self-professional field, 2.) Knowledge, career analysis, knowledge of technology and language, 3) applied skills to use material tools to perform tasks, communication skills, learning skills, analytical thinking, problem-solving, safety in the profession, and 4) the ability to apply responsibility. Therefore, many institutions focused on preparing students to plan, solve problems under professional knowledge, and take responsibility for themselves and others. In the vocational education system, the major of mechatronics engineering is a popular topic because it is important to develop a country. Therefore, the curriculum emphasizes professional performance in the specific subjects when students graduate. They must have knowledge and skills of industry needs. Singburi Technical College is a vocational institution that has a degree in mechatronics and robotics program that is a field that meets the needs of new industry groups. The objective is to develop students to match their professional performance.

In this study, we have developed a curriculum design cooperating with the establishment in an industry (From an apprenticeship course for 1semester, teachers who teach according to their experiences are not consistent with the establishment, making students unable to work) with applying an outcomes-based learning approach for students in Mechatronics and Robotics program. It focuses

on managing learning activity in the curriculum that aims at industrial variables, especially manufacturing. Provide students opportunities to develop skills solutions, joint operation, communication, build self-confidence and create a positive attitude towards learning activity.

2. Related Works

2.1 Outcome-based Learning

Outcomes-based learning (OBL) is entirely student-centered, which focuses on what students know and can do. OBL approach focuses on student learning outcomes beyond mere tinkering with traditional structures and methods. It constitutes a paradigm shift in educational philosophy and practice (Tam, 2014). Aldridge et al. (2006) find that the OBL makes significant contributions to learning environments because the instrument developed captures essential aspects of the learning environment associated with outcomes-based education. Deneen et al. (2013) proposed teaching and learning based on results. The course design framework for instructional purposes helps focus on the results of students. Then, learning instruction and assessment are provided to maximize the possibilities for students to achieve those results or goals.

2.2 Project-based Learning Activities

Project-based learning (PBL) is a learning model based on the constructivist theory that focuses on students gain a deeper understanding of material when they actively construct students' knowledge by working with and using ideas. (Chookaew et al., 2017). Dogara et al. (2020) proposed PBL as a pedagogical method, has the capability of students integrating soft skills among students at technical colleges. In addition, project-based learning management has a flexible process that focuses on implementing PBL strategies as a guideline for classroom learning activities. It is the assignment of students to work on projects outside school hours or in addition to activities and general coursework. The length of time it takes to manage project-based learning is flexible. It depends on the process of seeking knowledge to obtain information also needs to be flexible and adaptable to the situation or needs of the students. They have questions, determine methods, find answers, and choose answers or do activities.

3. Outcomes-Based Learning in Mechatronics and Robotics Program

This study proposed a learning approach applying in the mechatronics and robotics program at Singburi Technical College. The curriculum design in the part of studying in the educational institution must be consistent with the job characteristics that the establishment expects that used to build on the professional training plan of the establishment. The student graduated degree in a Certificate in Vocational Education in 3 years (6 semesters). After that, they can be continued in Higher Diploma in Vocational Education in 2 years (4 semesters) including learned significant basic knowledge and skill at institution one year then they will have an internship for one year. The program is working with cooperation between educational institutions and enterprises to apply specified guidelines to the curriculum design for teaching and learning. According to the survey, the nature of work in the industrial sector where students work. The performance characteristics of students of the mechatronics and robotics program at Singburi Technical College. It indicated that the establishments that have joined with the fields of mechatronics and robotics need the student work by professional competence can be summarized into four tasks, as shown in Table 1.

Table 1. *The requirements of establishment*

Task	Expected performance
1	Pneumatic system work and hydraulics
2	Wiring work, wiring assembly, installation of control cabinet

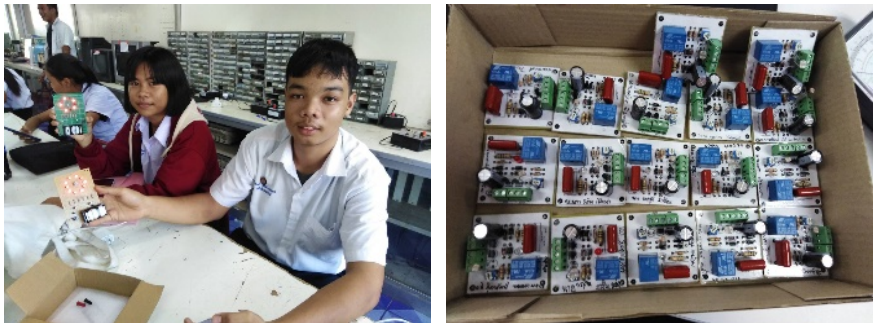
3	Drawing and design of machine parts
4	Development and design work of automatic machines

4. Results

The results of implementing project-based learning activities based on student learning outcome for the students in mechatronics and robotics program at Singburi Technical College.

Table 2. *Certificate in Vocational Education, year 1: semester 1*

Project-based Activity	Outcome-based Learning
It integrates DC circuits, electrical and electronic measuring instruments, electronics and circuits, introduction to electrical and electronic work, and electronic drafting. The students have made the speed adjustable flashing light project, and the DC power supply project, adjusted 0-30V, as shown in Figure2 (a) and (b).	1. Students can understand the operation of electronic devices. 2. Students can use electrical and electronic measuring instruments. 3. Students can assemble electric and electronic circuits.



(a) (b)

Figure 2. The student projects.

Table 3. *Certificate in Vocational Education, year 1: semester 2*

Project-based Activity	Outcome-based Learning
It integrates industrial electronics, mechanical parts in mechatronics, and electronic drafting with a computer. The students will be working on the switch phase control project with a car running along the line using electronic control circuits, as shown in Figure 3.	1. Students can design electronic circuits with computers. 2. Students can design a PCB with a computer. 3. Students gain skills in manufacturing mechanical parts using a 3D printer and a laser cut machine.

Figure 3. The project of a car running along the line using electronic control circuits.

Table 4. *Certificate in Vocational Education, year 2: semester 1*

Project-based Activity	Outcome-based Learning
It integrates pneumatics and hydraulics system, electrical and electronic drafting in mechatronics, and electromechanical and control. The students will be working on a pneumatic system with a relay circuit and a digital circuit project, as shown in Figure 4.	1. Students can design pneumatic systems with relay circuits. 2. Students can wire the wires, assemble and install the control cabinet. 3. Students can assemble and repair electronic circuits such as digital circuits, relay circuits.

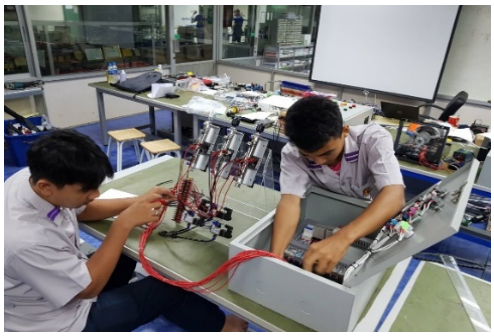


Figure 4. Pneumatic control project with relay circuit.

Table 5. *Certificate in Vocational Education, year 2: semester 2*

Project-based Activity	Outcome-based Learning
It integrates microcontrollers and computer programming design of mechanical parts with Solidworks software) and CNC technology fundamentals. The students will be working on a robot project that uses a microcontroller to control, as shown in Figure 5.	1. Students can write a control program with a microcontroller. 2. Students can design electronic circuits and PCB designs. 3. Students can design mechanical parts with the Solidwork program. 4. Students gain skills in manufacturing mechanical parts and can use 3D Printer, Laser Cut, and CNC machines.

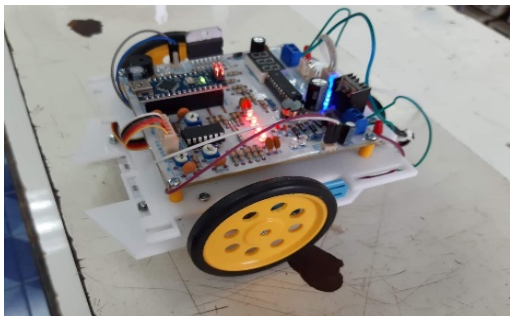


Figure 5. Microcontroller robot project.

Table 6. *Certificate in Vocational Education, year 3: semester 1*

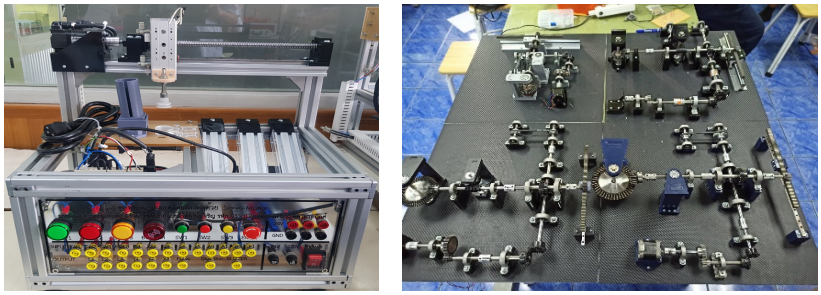
Project-based Activity	Outcome-based Learning
The section integrates the basic concept of robotics, interface, automatic control, and programming logic control. The students must complete the project based on students' interests. They synthesize and integrate all subjects studied into the building project.	1. Students can design electronic circuits. 2. Students can design a PCB pattern. 3. Students can design mechanical parts using the Solidworks program. 4. Students can write control programs with a microcontroller and interfaces with the IoT system.

Table 7. *Certificate in Vocational Education, year 3: semester 2*

Project-based Activity	Outcome-based Learning
The students have an internship in an establishment for four months at a company or industry that cooperates with the college and accepts the students for professional experience.	1. Students can design automation related to mechatronics and robotics. 2. Students can develop an automated system related to mechatronics and robotics.

Table 8. *Higher Diploma in Vocational Education, year 1: semester 1*

Project-based Activity	Outcome-based Learning
It integrates a Programmable Logic Controller to control Pneumatics and Hydraulics, mechatronics drafting, and mechanical parts in mechatronics. The students will be creating the project of a system for sorting objects controlled by a programmable logic control program and mechanical parts projects in mechatronics. Figure 6 (a) and (b).	1. Students can design automated machines and mechanical parts design using the Solidworks program. 2. Students can write programs to control automation machines. with programmable logic controllers 3. Students can produce mechanical parts and use 3D printers, Laser cuts, and CNC machines.



(a) (b)

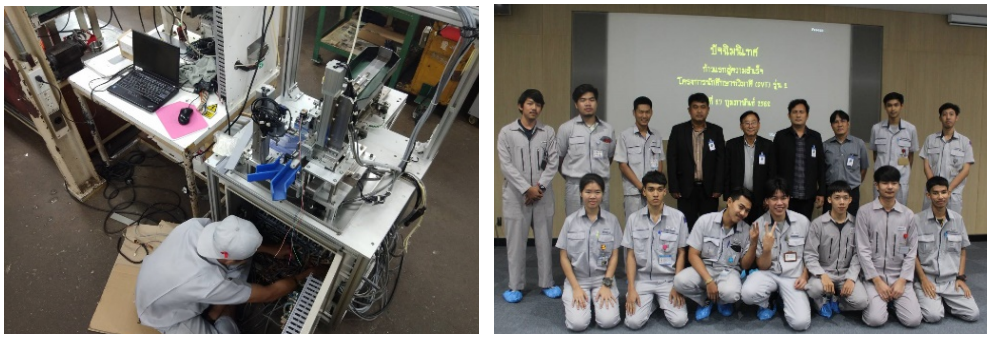
Figure 6. The students' projects.

Table 9. *Higher Diploma in Vocational Education, year 1: semester 2*

Project-based Activity	Outcome-based Learning
It integrates electrical circuits and electronics, digital and microcontrollers, CNC/CAD/CAM technology, and industrial robotics. The students will be working on a robotic project to move objects.	1. Students can design electronic circuits and design PCB patterns. 2. Students can design mechanical parts using the Solidworks program. 3. Students can write a control program with a microcontroller. 4. Students can produce mechanical parts and use 3D printers, laser cuts, and CNC machines.

Table 10. *Higher Diploma in Vocational Education 2 Semester 1 and 2 (Internship)*

Project-based Activity	Outcome-based Learning
The students will go to an internship in an establishment for one year that cooperates with the college to recruit students for professional experience training in a bilateral system. The students will have to work on projects to solve problems in the production process of 1 project, which will integrate all courses that students have studied. Figure 7 (a) and (b).	1. Students can improve the project related to mechatronics and robotics following the assignment. 2. Students can design automation related to mechatronics and robotics. 3. Students can develop an automated system related to mechatronics and robotics.



(a) (b)

Figure 7. The project of students' internships at workplace.

5. Conclusions

This study aimed to propose that the curriculum is designed with a learning approach, outcome-based learning, and what students need to know in each grade level with a project-based learning activity.

Our findings on the students have empirical academic performance. They receive a national award from many robotics and automation competitions such as a mechatronics skill competition, programmable controller skills, robot control, and industrial automation competition.

The study results would provide curriculum designers with the knowledge required to update the technical colleges' curriculum to accommodate the outcome-based learning elements found essential for the successful incorporation of vocational institutions and industry. Based upon the study's outcomes, we suggest a future study that should provide an adequate enabling environment for appropriate OBL to enhance the integration of student performance for effective development of knowledge and skills. Technical teachers should appropriately employ the PBL approach in teaching and learning.

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