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Developing a PLCs Experimental Kit through Role-playing for Students in Vocational Education

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Abstract: The traditional teaching methods of teachers are lectures and assignments to students' tasks in the classroom. Sometimes the students lack enthusiasm, resulting in poor academic performance. Providing teaching and learning that allows students to experience real-life situations is a prerequisite for future work. Furthermore, in the industry, Programmable Logic Controllers (PLC) are used in automatic control systems. Therefore, studying in a PLC course, students should be exposed to real-world situations. Role-playing teaching is one way to help students experience real-life situations for future work and makes the learning process more interesting, fun, and motivating. Thus, this study proposes using role-playing for learning on PLC courses for vocational certificate students. Role-playing activities to help in learning can promote students to functional skills for using PLC for controlling the operation of the input/output devices. Moreover, the student can develop their knowledge, skills, and abilities according to the course competencies and use them for real work in the future.

Keywords: PLC, learning strategy, STEM, vocational education

1. Introduction

Programmable Logic Controller (PLC) course has purposed for students to understand the structure, symbols, characteristic of PLC and input/output device, programming of motor and input/output devices control, skilled in installing input/output devices and writing, editing logic control programs in ladder language to motors and input/output devices control. It focuses on performance in applying PLC to motors and input/output devices control. The PLC scheme's basic capability controls the on-off input and output devices by programming. There is a sequence control to achieve the function of the devices that are related to each other. This is an essential foundation for learning and applying to PLC (Chookeaw et al., 2019; Howimanporn et al., 2018).

The traditional teaching methods of teachers are lectures and assignments to students' tasks in the classroom. Sometimes the students lack enthusiasm, resulting in poor academic performance. Providing teaching and learning that allows students to experience real-life situations is a prerequisite for future work. Therefore, the teachers should also apply the STEM framework for developing students' knowledge, skills, and abilities, especially in the PLC course with learning approaches such as active learning and problem-based learning to drive the learning process with the real situation in daily life. To develop the learning process and make students understand the content, have skills, and develop thinking processes to solve the problem. We are interested in the role-playing learning process.

Bonwell & Eison (1991) presented role-playing techniques that allow students to assume a person's role or act out a given situation. These roles can be performed by individual students, in pairs, or in groups which can play out a more complex scenario. This technique can engage students in real-life scenarios, which require them to examine personal feelings toward others and their circumstances.

Therefore, we designed a role-playing model to drive learning activity with the experimental set in the PLC course for students in a vocational college.

2. Related Works

2.1 Role-playing Technique

Role-playing is a learning technique that allows students to explore realistic situations by interacting with other people in a managed way to develop experience and trial different strategies in a supported environment. In addition to learning the intended concepts and principles, role-playing enactment of real-life situations promotes critical thinking skills and humanizes science by discerning its importance to everyday life. It can also develop important skills needed in the real world, teamwork, collaborative learning, and effective communication.

Many studies suggested role-playing techniques to promote student learning. For example, Fadali & Robinson (2013) presented four stages of role-playing activities consisting of preparation and explanation of the activity by the teacher, the classroom preparation of the activity, the enacting of the activity by the class, and the discussion of the enactment known as debriefing. Wahyudi & Hadiyat (2020) proposed a series of integrated activities for role-playing that align with learning objectives to achieve the relevant hard skills or soft skills for engineering students. Zowghi & Paryani (2003) employed using role-playing in teaching requirement engineering for undergraduate students. It found the requirement engineering subject outlined to be very effective, where students gained a better understanding and encouraged the students' needed mindset. Gómez-Poyato et al. (2020) proposed an active learning methodology in university degrees with flipped classrooms and role-playing, which requires a higher degree of student involvement, greater dynamism in learning, and increased content interaction.

Moreno-Guerrero et al. (2020) presented the students positively valued applying the role-playing method, obtaining better scores in the set of variables studied such as motivation, creativity, and collaboration through technology to increase multiple skills. Barrera et al. (2020) proposed role-playing simulation activities in a higher education institution that employed role-playing simulation activities to achieve student learning.

2.2 The content of Programmable Logic Controller (PLC) Course

PLC are widely employed in manufacturing to coordinate and control complex tasks in the industry. It is designed to connect multiple inputs and output configurations with software programs. In addition, PLC remains the best option for industrial automation to execute future manufacturing and production processes.

In Thailand, the vocational Certificate Program PLC course focused on student skills and performance, especially work skills. Therefore, learning outcome in this study are students can be:

- Understanding the characteristic of PLC and input/output devices.
- Writing PLC programming with input/output devices and motor drive.
- Writing instructions and edit program under the specified conditions.
- Testing the operation and maintenance.

3. Designed a role-playing Model

3.1 Design of Role-playing Activity

In the traditional classroom and experiment, the teacher determines the PLC control system's working conditions for the students. When students succeed, the teacher checks and scores them, which the learners do not have the same role in expressing their ideas as the actual working specified conditions. This role-playing teaching will simulate the experiment like the actual situation by dividing the students into two students and assuming one of them will act like an engineer. Engineer assigns the PLC operating conditions to another student acting as a technician who writes the PLC control program according to the specified conditions and changes roles on the next occasion. The students are vocational level three in electronics engineering and used three hours for each occasion that use all six hours. A role-playing model is depicted in Figure 1.

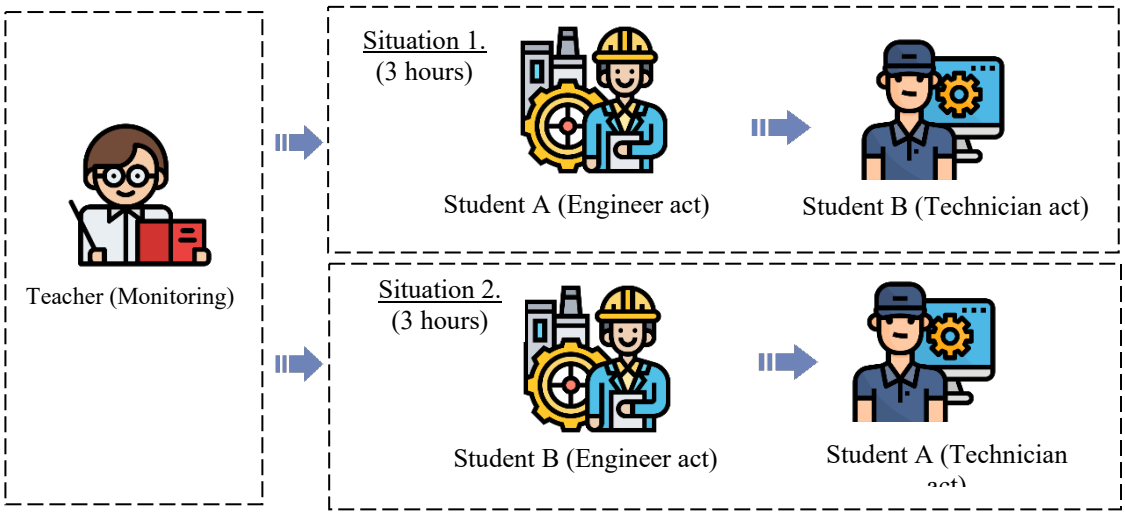

Figure 1. A role-playing framework.

3.2 Design of Experimental kit

In this study, we have designed an experimental kit as a learning material to use in a learning activity (hands-on activity) the PLCs concepts, as shown in Figure 2 below.

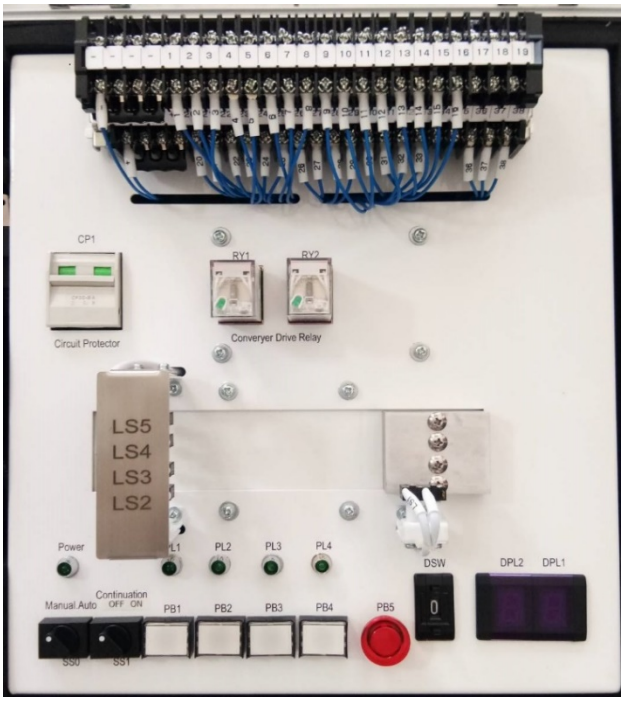

Figure 2. The structure of experimental kit.

In addition, we have designed the input device consisting of two selector switches (SS0 and SS1), four push-button switches (PB0, PB1, PB2, and PB3), one emergency switch (PB5), one thumbwheel switch is BCD 4 bits (DSW), and five limit switches (LS1, LS2, LS3, LS4, and LS5). In addition, the output device consists of 4 led displays (PL1, PL2, PL3, PL4, PL5), two digits of the seven-segment display are BCB 4 bits (DPL1 and DPL2) and two relays for drive DC motor (RY1 and RY2). All are connected to terminal block (TB) for wiring with PLC, as shown in Figure 3.

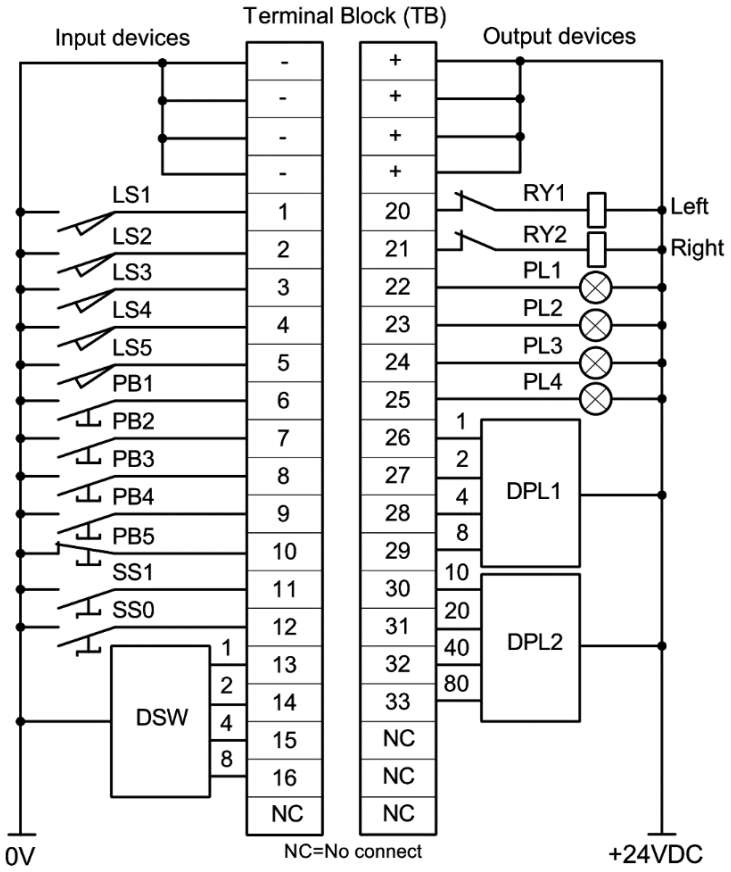

Figure 3. The Input and output devices diagram.

In input/output devices panels, a belt-driven mini conveyor with a DC motor drives the pallets to move left and right. The pallet itself is equipped with a screw to allow the sensing limit switch, as shown in Figure 4 below.

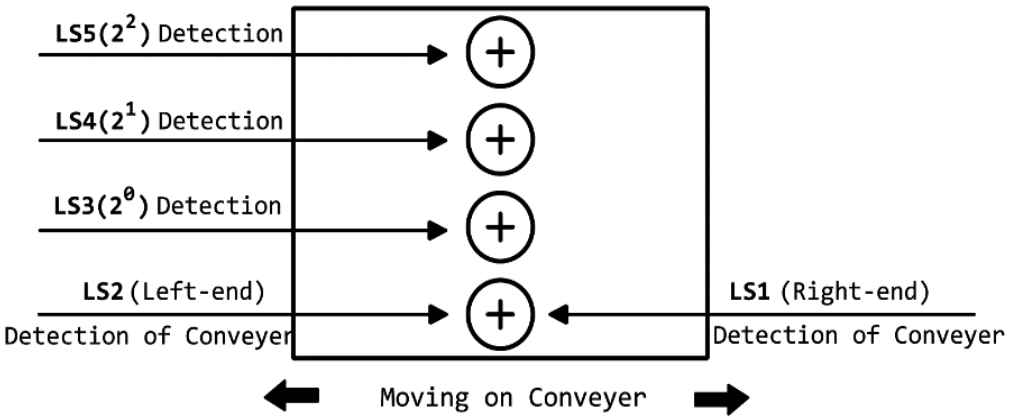

Figure 4. A pallet for sensing limit switch.

4. Results

The design above reveals that the proposed role-playing activity for vocational education students promotes programmable logic controller (PLC) learning.

4.1 Learning Activity with PLCs kit

We proposed a teaching and learning PLC through role-playing have four steps as follow:

- *Step 1:* Studying the content and concept of PLC.
- *Step 2:* Setting student groups then inform the criteria and details of learning activities and assigned role-playing situations.
- *Step 3:* The students act as role-playing under the situation.
- *Step 4:* The teacher and students discuss the learning activities related to the results, feedback, and assessment.

Figure 5. An activity role-playing for PLC learning.

5. Conclusion

The advantage of this study is an alternative technique that allows the student to learn with real simulated situations to make students active, problem-solve, and have creative thinking, which has resulted in academic achievement and performance. Therefore, we designed role-playing teaching for the PLC course. As a learning activity, we design to divide the students into groups. Each group has two students and assumes they will act like engineers and technicians. Engineer assigns the PLC operating conditions to another student acting as a technician who writes the PLC control program according to the specified conditions and changes roles on the next occasion. In addition, we employ an experiment kit designed according to the content of the PLC course through role-playing activities that will allow students to experience real-life situations in their future work, in which learners must use knowledge, skills, and experience to get the job done and efficiently.

In the future, this model will be used in vocational education. We have an experimental design to study the comparison between the sample groups and the impact of this finding. This work is described here will be extended into more research.

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