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# The effectiveness of learning in vocational education in mechatronics through making a simple simulation program

D Artanto<sup>1</sup>, E A B Cahyono<sup>2</sup>, A Siswoyo<sup>3</sup> and S M Effendi<sup>4</sup> <sup>1,2,3,4</sup>

Politeknik Mekatronika Sanata Dharma, Yogyakarta, 55282, Indonesia

E-mail: dian.artanto@pmsd.ac.id

**Abstract.** As one of vocational education in Indonesia, Politeknik Mekatronika Sanata Dharma must be able to produce graduates who are competent and skilled in the field of mechatronics. In order to achieve this, practical and workshop learning must be given a large portion. However, some practical tools available are limited, due to constraints in the cost of procuring equipment that is quite expensive. This paper presents an active learning through the practice of developing a simple industrial control simulation program, using Proteus and LabVIEW software. One example of the control simulation presented here is the control on the conveyor as a supplier of items. From the observation and learning evaluation, it was found that by making a simple simulation program, students more easily develop skills in mathematics, logical thinking and problem solving. The effectiveness of learning can be measured from the value of student satisfaction and involvement, which in the example here is quite high. Students were enthusiastic and involved, starting from the design of the conveyor simulation image, making the simulation circuit in Proteus, programming the microcontroller, and making the simulation program at LabVIEW, even to realizing it to the actual conveyor.

## 1. Introduction

One of the achievements of learning special skills in the field of Mechatronics referring to level 5 KKNI is being able to apply mathematics, natural science, and engineering principles into technical procedures and practices (technical practice) to solve engineering problems in the field of mechatronics that is clearly defined (well-defined) [1].

The ability to apply mathematics, natural science and engineering principles is a competency that needs to be developed by students of the PMSD D-3 Mechatronics Study Program, because it is related to his work as a technician in mechatronics. As a mechatronics technician, the technical problems that will be encountered are quite complex, because the mechatronics field is a combination of mechanical, electrical and control fields. In addition, the rapid development of mechatronics technology has made solving engineering problems difficult [2].

Development of logical and mathematical thinking skills is not enough just to teach theory and provide mathematical and natural science problems, because students tend to be bored. Especially with so many information and social media around students, making student attention easily distracted. For this reason, it is necessary to have innovative and challenging learning that arouses students' interest to learn it.

In addition to being able to apply mathematics, natural science and engineering principles, a mechatronics technician must also be skilled in solving engineering problems. These practical skills can not only be taught in theory, but must be done by direct practice, which is often known as learning by



doing. In order to carry out this practice directly, of course adequate practice equipment is needed. However, practical equipment in the field of mechatronics is certainly quite complex and expensive [2].

To overcome difficulties in teaching mathematics and natural science, and to overcome the problem of the high cost of practical equipment, this paper proposes a learning method with an approach through making a simulation program, using popular and easy-to-use software, namely Proteus and LabVIEW [3, 4]. Why does it have to be done through making a simulation program? Because by making simulations, students indirectly apply mathematics and natural science. In addition, making a simulation program only requires computers and software that can be downloaded for free (evaluation version), to eliminate the cost of procurement and maintenance of expensive practice equipment.

## 2. Literature Review

Simulation has been well known as an educational tool. Instructors in engineering use simulations in learning because they are easy to use, can be stored, and can visualize how a system works [5]. Students like the use of simulation, because it provides freedom and flexibility for students to experiment anytime and anywhere [6].

Learning by making simulation programs, is one form of project-based learning. Project-based learning has been widely applied in technical education, because it is considered quite effective. PBL becomes the preferred learning method especially in learning that involves several fields of science, such as mechatronics [7]. Project-based learning provides opportunities for students, teachers, and community members to collaborate with each other. Project-based learning also builds student confidence and allows them to think, develop and design new ideas and approaches through their teamwork [8].

Project-based learning also needs to be applied in practice in the laboratory. As is known, that practical or technical skills are one of the important skills in the engineering sector. Practical skills require "hands-on practice" as a key to understanding and solving some unpredictable real-world problems. This direct practice can only be done if laboratory equipment is available. However, some practices in the laboratory are stuck in experimental procedures. Students just follow the procedure and finish with a little knowledge of what is being done. With the application of project-based learning, making practice in the laboratory a focus on learning, improving practical skills and student participation in a team [9, 10].

## 3. Method

Project-based learning in the form of making a simulation program is carried out with the following stages:

1. Students in groups get an overview of the project to be made
2. Students in groups get simple sample programs
3. Students in groups develop examples of programs that are given
4. Students in groups discuss development ideas
5. Students in groups realize development ideas
6. Students in the group consult with the facilitator (instructor/lecturer)
7. Students in groups present the results of the project made
8. Students in groups give reports on projects that have been made

To provide an overview of the project to be created, the following is an example of a project description:

The project description: Create an interactive display of the Items Supplier, in the form of a conveyor, which works with the following conditions:

- The Items Supplier is a tool that can regulate the supply of items on a regular basis, so that the taker of items can take items at any time without having to wait too long. Items are taken at the end of the conveyor. Every time the items have arrived at the final endpoint, the conveyor will stop. If the items are taken, then as soon as possible the next item must be moved to the endpoint of the conveyor. The tool is said to be reliable when the waiting time for retrieval is getting shorter.

- This Items Supplier has 2 light sensors, each of which is placed at both ends of the conveyor
- To be clearer, here is a flowchart of how the Items Supplier works

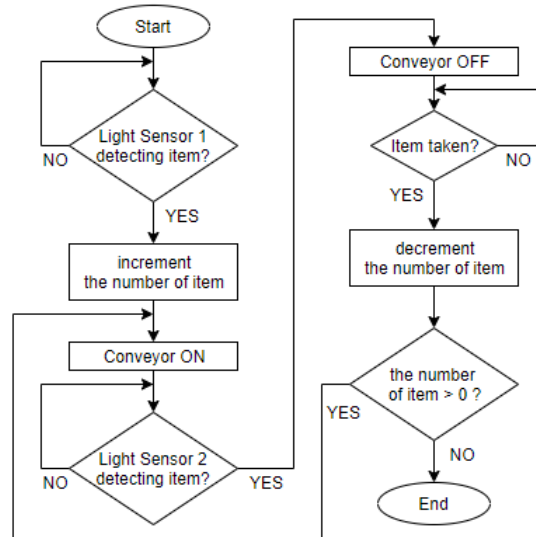


Figure 1. The flowchart of the Items Supplier.

The following are examples of programs given as triggers for student involvement:

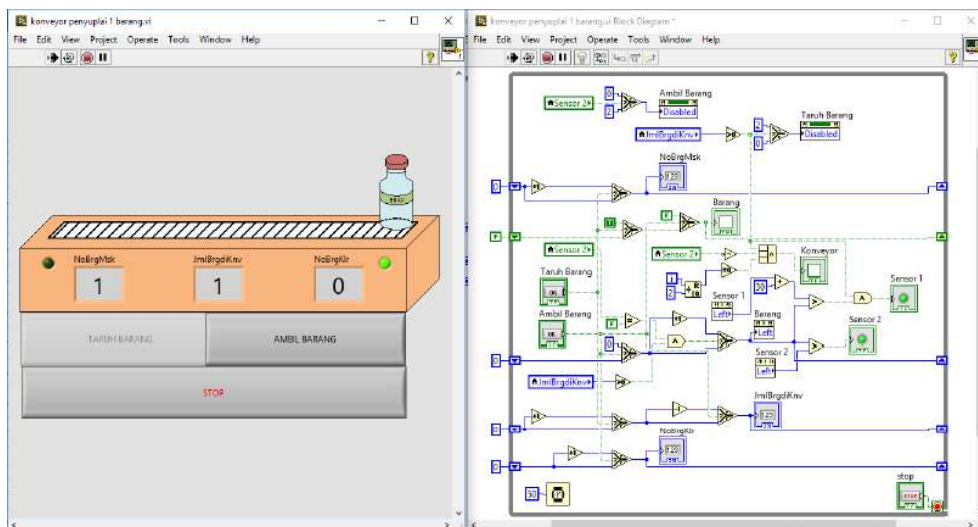


Figure 2. A simulation program of the Items Supplier.

#### 4. Result

The following are examples of developing ideas from students, which can be listed as follows:

1. Items that are moved on conveyors are more than 1 item.
2. The addition of an external control in the form of 2 buttons from Arduino.
3. The addition of conveyor drive motor hardware.

The following is the implementation of the development ideas above, which were done in groups and collaboration between groups:

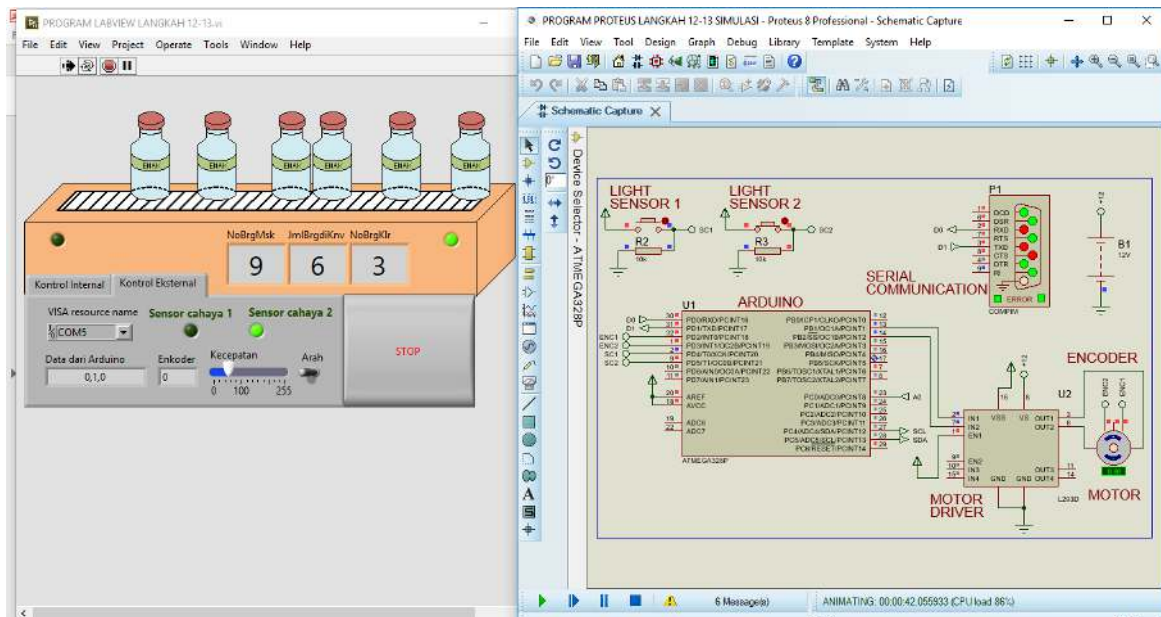


Figure 3. The result of collaboratively developing ideas.

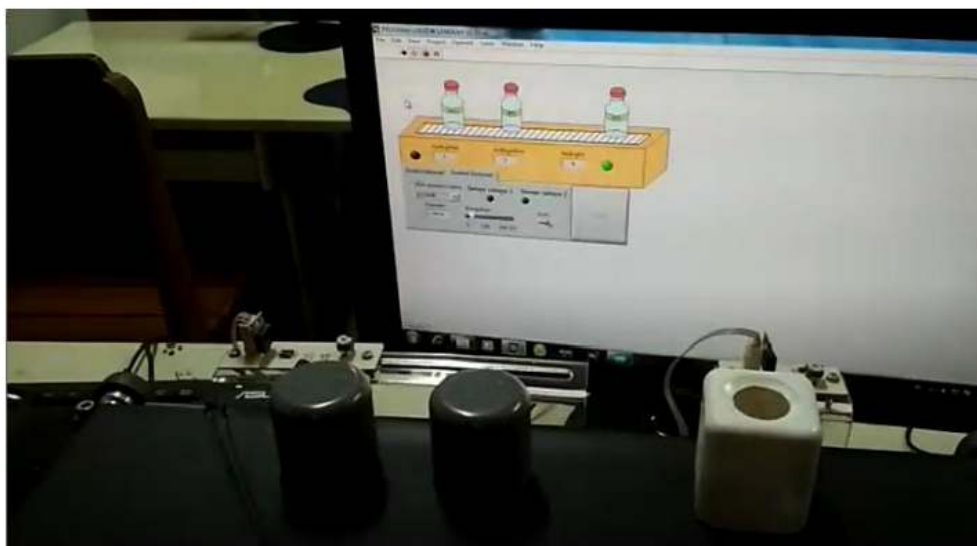
After successfully designing an interactive display, making a series of simulations on Proteus, making a microcontroller program and creating a tool provider simulation program with LabVIEW, furthermore, students were enthusiastic to realize the conveyor simulation into their real hardware, and connect it to the computer. The following photos show how the program at LabVIEW, displays the same amount of items as the items carried by real conveyor.



Figure 4. The LabVIEW program displays 1 item as in its real conveyor.



**Figure 5.** The LabVIEW program displays 2 items as in its real conveyor.



**Figure 6.** The LabVIEW program displays 3 items as in its real conveyor.

## 5. Conclusion

Project-based learning in this paper has been applied in the form of making a simulation program, which mimics the workings of a conveyor supplier of items. The program idea was developed by students, by giving a trigger in the form of a simple program example. Students in groups are guided to understand and be able to make their own simple programs. Then students are given the freedom to add to the simple program, ideas that are logical and reasonable, which indeed must be present. The development of these ideas became the target of each group's project. Lecturers in this case only become facilitators and consultants, who provide direction for the programs that have been made by students.

The effectiveness of learning can be shown from the high value of satisfaction, both students and lecturers. Also, from the involvement of students, ranging from designing to realizing the program, even manifesting it on a real conveyor, showed evidence of high student involvement and enthusiasm.

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