Development of Practicum Tools DC Motor Speed Control System as a Learning Media of Robotics Learning Practice

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Abstract. The purpose of this research is to: (1) Understand how the DC motor control systems trainer works, and (2) measure the feasibility of DC motor control systems trainer as a learning media. This research applies research and development approach and ADDIE (Analyze, Design, Develop, Implement, Evaluate) model. The research was conducted in mechatronic engineering education study program, Yogyakarta State University with the students of mechatronic engineering education as the subjects of the research. Based on this research, it is known that: (1) Vexta series of DC motor control systems trainer can control the speeds appropriate with the input speed, and (2) The result of feasibility assessment by material experts obtained an average score of 50.5, that included in the “feasible” category, while the media experts feasibility obtained an average score of 72, that included in the “very reasonable” category. For the students’ assessment results based on the experiment on small group, 50 % of the students agreed that the material is “feasible” category, while another 50% agreed that it is “very reasonable” category. For the assessment on operational products, 65 % of the students agreed that it is “feasible” category, while another 30 % agreed that it is “very reasonable” category, and the other 5 % agreed that it is “good enough” category, to be applied as a learning media.

1. Introduction
Higher education is one of the government's solutions in the development of students who are able to advance domestic technology. Higher education is a continuation of secondary education that is held to prepare students to become members of the community who have academic and professional abilities that can apply, develop science, technology and arts (Law No. 2, 1989). In higher education there are many fields of expertise that are offered to students to learn. Each existing field of expertise makes students focus in their learning and has a clear direction for their future.

Department of Electrical Engineering Education (JPTE) Faculty of Engineering (FT) Yogyakarta State University (UNY) as one of the higher education institutions, including those affected by changes in DU/DI. Changes that occur in the area of controlling machines or tools in the DU / DI are not all and cannot always be followed by JPTE, so it becomes less conducive to learning [5].

Mechatronics Engineering Education Program, Department of Electrical Engineering Education, YSU, which studied industrial control and robotics. One of the main subjects of the Mechatronics Engineering Education Study Program is the Robotics Practice course. In the course of robotics practice, learning science related to robots, starting from the design of robots, sensors, actuators, mechanical engineering, and programming. From the science of designing robots, sensors, actuators, mechanical engineering, and programming can later be expanded to other fields in the field of robotics, namely robot
kinematics including navigation systems, manipulation systems, image processing, intelligent robots and so on. Vexta series DC motors are actuators that are often used in the field of robotics. This Vexta series DC motor is a product of Oriental Motor, which is a type of brushless motor equipped with several sensors including a speed sensor and a current sensor. With this sensor it can be used as a feedback signal device to the controller to form a closed loop system.

Based on observations made in the Mechatronics Engineering Education study program, the Department of Electrical Engineering Education, Yogyakarta State University, in robotics practice courses, students are introduced to the basics of robotics that are still theoretical due to the small number of existing facilities and infrastructure. So students are less able to explore the capabilities and science of robotics more deeply. With the lack of available facilities and infrastructure, students have not been able to test the practice of robotics to develop their knowledge. This causes students’ interest and motivation to learn is low.

Efforts to increase students’ interest and motivation to learn need to develop adequate learning media. Through innovative learning media students can be more motivated to learn and improve their understanding in the field of robotics. In particular, the notion of media in the learning process tends to be interpreted as graphic tools, diagrams, slides (ppt) that serve to convey messages or visual or verbal information [3][5]. Gerlach and Ely explain the media when it is understood that it is broadly human, material and events that establish conditions that make students able to obtain knowledge, skills or attitudes [1]. In this sense, educators, textbooks, and the school environment are media. While Criticos explained that quoted by Daryanto the media is one component of communication, namely as a messenger from the communicator to the communicant [4]. Based on some of the opinions above it can be concluded that the media are all things or components that can be used to channel messages from the sender to the recipient so that they can stimulate the thoughts, feelings, attention and interests of students in the learning process.

The use of instructional media in the teaching and learning process can arouse new desires and interests, arouse motivation and stimulation of learning activities, and even bring psychological influences on students [5][6]. From the above problems the researcher intends to use learning media that is more applicable to the industrial world and is able to motivate students to study harder.

2. Method and Types of Research
The type of research applied is development research. This research produces a product in the form of a DC motor speed control system trainer as a learning medium for robotics practice. Product development applies the ADDIE model (Analyze, Design, Development, Implement, Evaluate) from Robert Maribe Branch [2].

Product development applying the ADDIE model includes analysis, product design, product development, implementation and evaluation. Analysis is carried out on teaching and learning activities then prepared appropriate learning media. Learning media in the form of a trainer applies a closed loop control system with a rotary encoder transducer. The product design begins with making the transfer function diagram and system block diagram. Making a gradual trainer from making hardware is continued by making software. Trainer that has been formed needs to pass validation from expert lecturers before applying it to teaching and learning activities.

This research began in July 2016 until completion. The research location is in the Department of Electrical Engineering Education, Faculty of Engineering, Yogyakarta State University. The research subjects were students of the Mechatronics Engineering Education Study Program, Faculty of Engineering, Yogyakarta State University.

Data obtained from respondents were processed and analyzed by quantitative descriptive statistics. The quantitative data of the feasibility instrument was changed into four categories of feasibility namely very feasible, feasible, sufficiently feasible and not feasible.
3. Results and Discussion
The product produced in this research is learning media in the form of Vexta series DC Motor Speed Control System Trainer and lab worksheet. The learning media of the Vexta series DC Motor Speed Control System was developed through the ADDIE development research method proposed by Robert Maribe Branch. This learning media uses several types of components including: ATmega16 Microcontroller, Rotary Encoder as speed sensor, one for Vexta series DC motors as actuators, keypads to provide input values for motor and LCD speeds to display input data and output speed of the Vexta DC series motors.

After being developed, this learning media took several tests. First is testing the blackbox to find out the learning media's functionality. The results obtained are the learning media trainer speed control system of this DC motor Vexta series can function properly according to the program that has been made.

When testing the instructor media of the Vexta series DC motor control system, there were some disadvantages. The learning media is still less informative for the speed unit value on the LCD, so an additional speed is needed to be displayed on the LCD. In addition, the absence of a stop button on the learning media hardware is also an input that, this learning media is less practical. Because there are only one tool, this learning media must be used interchangeably.

3.1. Result
This study aims to: (1) Determine the test results of the learning media functionality, and (2) Determine the feasibility of learning media for the Vexta series DC Motor Speed Control System. Discussion of the results of this study is explained as follows.

3.1.1. Learning Media Performance
The learning media performance is assessed from the blackbox test. The results of the analysis of the performance data is known by testing each function of the instructor learning media section of the Vexta series DC motor speed control system. The test data shows that all trainers of the Vexta series DC motor speed control system are functioning normally. After taking the blackbox test stage, the learning media are run according to the procedure and get the results that the program can control the motor speed according to the entered speed value.

3.1.2. The Feasibility Learning Media of Vexta series DC Motor Speed Control System Trainer
The feasibility of instructional media is assessed based on assessments by media experts, material experts and students. The feasibility assessment is explained as follows.

3.1.2.1. Expert Judgment of the Material
The assessment of the feasibility of learning materials by material experts is assessed based on two aspects, namely the relevance aspect of the material, and the technical aspects of learning media. The assessment data from media experts can be shown in Table 1.

| No | Aspect             | Average Score | Category |
|----|--------------------|---------------|----------|
| 1  | Relevance of Material | 33.50         | Worthy   |
| 2  | Technical Learning  | 17            | Worthy   |
|    | Media              |               |          |
|    | **Average Total Score** | **50.5**     | **Worthy** |

The conclusion of the feasibility of instructional media material based on data from the assessment of material experts obtained an average total score of 50.5 assessment with the category "feasible". Material experts assess learning media as "feasible" because the aspect of relevance of the material is in
according with the subject of robotics practice being taught. Furthermore, from the technical aspects of instructional media, instructional media are considered to have good design quality, can be operated easily and easily in their maintenance.

3.1.2.2. Assessment of Media Experts
Assessment of the feasibility of instructional media by media experts is assessed based on three aspects, namely aspects of expediency, aspects of device engineering and aspects of visual communication. The assessment data from media experts can be shown in Table 2.

| No | Aspect          | Average Score | Category      |
|----|-----------------|---------------|---------------|
| 1  | Usefulness      | 27            | Very decent   |
| 2  | Device Engineering | 31          | Worthy        |
| 3  | Visual Communication | 14          | Very decent   |
|    | **Average Total Score** | **72**      | **Very decent** |

The conclusion of the feasibility of instructional media based on data from the results of the assessment of media experts obtained an average total score of 72 with the category "very feasible". Media experts consider the Android-based learning media to be "very feasible" because of the usefulness of the media that supports the explanation of learning material. Furthermore, from the engineering aspect of the device, learning media can be used for other learning materials. From the aspect of visual communication considered to be able to attract students' interest in learning and can help students to understand the learning material.

3.1.2.3. Student Assessment
Response assessment by students contains product assessments in terms of aspects of material quality, aspects of performance, and aspects of expediency. Student assessment of learning media is obtained from small group trial data and operational product tests.

3.1.2.3.1. Evaluation of Small Group Trials
Assessment in small group trials is carried out by 8 students to determine students' assessment responses on a small scale. Data on student assessment results in small group trials is explained in the frequency distribution table in Table 3.

| Category        | Frequency | Percentage (%) |
|-----------------|-----------|----------------|
| Very decent     | 4         | 50,00          |
| Worthy          | 4         | 50,00          |
| Decent enough   | 0         | 0,00           |
| Not feasible    | 0         | 0,00           |
| **Total**       | **8**     | **100,00**     |

Based on the data in Table 3, the total frequency distribution of learners' scores in small group trials is presented in the form of a diagram in Figure 2.
Based on the frequency distribution diagram in Figure 2 it can be seen that 50% of participants in a small group trial stated that learning media in the feasible category as learning media and 50% of other students rated the media in the category very feasible to be used as a learning media. The conclusion was obtained that the Vexta series DC motor trainer speed control system learning media is "very feasible" to be used as a learning medium.

Learners assess learning media as "very feasible" to use because: (a) Aspects of the quality of the material, the portion of the material delivered is in accordance with the capacity of students, and is equipped with a labsheet; (b) Performance aspects, learning media are considered easy to operate and run well, the program is able to control the motor speed according to the input value; and (c) Aspects of expediency, learning media are considered to be able to attract students' interest in learning and make it easier for students to understand the learning material.

3.1.2.3.2. Assessment of operational product tests
The assessment on the operational product test is carried out by 20 students to determine the response of the end user assessment. Student assessment results data on the operational product test is explained in the frequency distribution table in Table 4.

Table 4. Frequency Distribution of Operational Product Test Results

| Category          | Frequency | Percentage (%) |
|-------------------|-----------|----------------|
| Very decent       | 6         | 30,00          |
| Worthy            | 13        | 65,00          |
| Decent enough     | 1         | 5,00           |
| Not feasible      | 0         | 0,00           |
| **Total**         | **20**    | **100,00**     |

Based on the data in Table 4, the total frequency distribution of learners' scores on the operational product test can be presented in the form of a diagram in Figure 3.
Based on the frequency distribution diagram in Figure 3 it can be seen that 30% of students in the operational product test stated that learning media in the category are very feasible as learning media, while 65% of students rate learning media in the appropriate category as learning media and 5% of students others considered learning media in the category quite feasible to be used as learning media. The conclusion was obtained that the learning media trainer speed control system DC motor Vexta series "feasible" is used as a learning medium.

Learners assess learning media as "very feasible" to use because: (a) Aspects of the quality of the material, the portion of the material delivered is in accordance with the capacity of students, and is equipped with a labsheet; (b) Performance aspects, learning media are considered easy to operate and run well, the program is able to control the motor speed according to the input value; and (c) Aspects of expediency, learning media are considered to be able to attract students' interest in learning and make it easier for students to understand the learning material.

On the other hand, students assess that there are deficiencies in learning media, namely the material delivered is less extensive, only one learning media, and the need for a GUI display on a computer for response graphs.

4. Conclusion and Recommendations

4.1. Conclusion

Based on the results of research and discussion of the development of instructor learning media trainer speed control system of DC motor Vexta series, the following conclusions can be drawn:

a. Development of learning media trainer speed control system of Vexta DC motor using several electronic components including: ATMega16 Microcontroller, LCD, Keypad, Vexta series DC Motor and Rotary Encoder. As for making programs for speed control using the Code Vision AVR software. The results of the trainer functionality test of the Vexta series DC motor control system can control the motor speed using a rotary encoder transducer by providing feedback to the microcontroller. With speeds ranging from 50 - 600 rpm, constants 0 to 20, and constants 0-10, constants 0 to 20.

b. The feasibility of learning media trainer speed control system of DC motor Vexta series based on the assessment by material experts obtained a score of 50.5 included in the category of "feasible" to be used as a learning medium. The feasibility assessment by the media experts obtained a score of 72 included in the category of "very feasible" used as a learning medium. Evaluation of students in small group trials obtained 50% of students stated that learning media included in the category of "feasible" as learning media, and 50% of other students stated that learning media included in the category of "very feasible" as learning media. The results of the assessment of students in the operational product test obtained 65% of students stated that learning media included in the category of "feasible" as learning media, while 30% of students stated that learning media included in the category of "very
feasible" as learning media and 5% of participants students state that learning media is included in the category of "reasonable enough" as a learning medium.

4.2. Recommendation
Based on the research that has been done, the advice given for the next research related to the development of instructional media trainer speed control system of DC motor Vexta series, namely:

a. Making learning media needs to be duplicated so that learning robotics practices is more effective.

b. Developing other trainer's abilities so that they can be used for other learning.

c. Developing more applicable media as a follow up to the motor speed control system practicum.

5. References
[1] Azhar Arsyad 2011 Media Pembelajaran (Jakarta: PT. Raja Grafindo Persada)
[2] Bektı Wulandari dkk. 2015 Pengembangan Trainer Equalizer Grafis dan Parametris Sebagai Media Pembelajaran Mata Kuliah Praktik Sistem Audio (Vol.22. No.4. Hlm.375)
[3] Branch, M. Robert 2009 Instructional Design The ADDIE Approached. (New York: Springer)
[4] Daryanto 2010 Media pembelajaran: Peranannya Sangat Penting Dalam Mencapai Tujuan Pembelajaran (Yogyakarta: Gava Media)
[5] Haryanto & Moh Khairudin 2012 Pengembangan Model Pembelajaran Jaringan Syaraf Tiruan Tipe Supervised Learning Sebagai Media Pembelajaran (Vol.21. No.1. Hlm.84)
[6] Muhammad Munir 2014 Pengembangan Media Pembelajaran Interaktif Kompetensi Dasar Register Berbasis Inkuiri Terbimbing. Jurnal Pendidikan Teknik dan Kejuruan (Vol.22. No.2. Hlm.185)