Development of Servo Motor Trainer for Basic Control System in Laboratory of Electrical Engineering Control System Faculty of Engineering Universitas Negeri Surabaya

by Puput Wanarti

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Abstract. In the Department of Electrical Engineering FT Unesa, there are 3 majors: S1 Electrical Engineering Education, S1 Electrical Engineering, and D3 Electrical Engineering. Courses the Basic System Settings go to in the curriculum of the three programs. Team lecturer college of basic system settings seek learning innovation, focused on the development of trainer to student practicum at the laboratory of systems control. Trainer developed is a servo motor along with the lab module that contains a wide variety of theories about the servo motor and guide the practicum. This research type is development research using methods Research & development (R & D). In which the steps are applied in this study is as follows: pay attention to the potential and existing problems, gather information and study the literature, design the product, validate the design, revise the design, a limited trial. The results of the validation of learning device in the form of modules and trainer obtained as follows: score validation of learning device is 3,64; score validation lab module Servo Motor is 3,47; and questionnaire responses of students is 3,73. The result of the whole validation value is located in the interval >of 3.25 s/d 4 with the category of "Very Valid", so it can be concluded that all instruments have a level of validity "Very Valid" and worthy of use for further learning.

1. Introduction

In an effort to increase the quality of learning outcomes for students of Electrical Engineering Unesa in particular the department of Electrical Engineering Education, then the team lecturer college System's Basic Settings have been conducting research with the innovation learning model. That is by applying Cooperative Learning Model (MPK) is completely supported by the module correctly. The module in this study is a practical module motor servo consists of Modules Students, Module Lecturers and trainer. Module Student contains (1) the Map position of the module and the ability prerequisites; (2) an Introduction that includes a description, prerequisites, instructions for use of the modules, competencies and indicators; (3) learning Activities, in which each learning activity includes the competencies and indicators, a description of the material, sheet of student activity and formative test that is not accompanied by the answer and (4) Evaluation that includes cognitive, affective and psychomotor.

Assessment team of experts to the module in the form of a response team of experts on: (1) Purpose, which includes the final destination is relevant to the curriculum of Department of Electrical Engineering Unesa and Learning Plan Semester (RPS) courses in the Basic System Settings. (2) the Concept or the Substance, which includes the truth of the concept, structured competency-based, is the substance of the principal essential oils, are grouped in parts that are logical (the material of each

learning activities relevant to the RPS), the material in accordance with the time available, related to the material of the previous (sequence), feasibility of tools and materials, the use of notation, symbols, and units, no bias of gender, ethnic, religious. (3) Format, which includes an agreed format, the numbering system is clear, the text and illustrations are balanced, the attractiveness module, (4) Language which includes the writing of the Indonesian Language that is good and true, the suitability of the language with the level of development of students, the phrase is written in an effective, efficient, and communicative, the definition clearly described and the terminology used appropriately, commands, instructions, and assignment are written clearly. (5) Illustrations, which includes help understanding the concept, lists the source, if the quote illustrations from other sources, illustrations presented in a clear, interesting, and easy to understand, not gender-biased, ethnic, religious. (6) Evaluation, which includes relevance to the learning objectives, equipped with a grating/table specifications, and guide the evaluation. (7) a Bibliography, which includes writing by default (referring to WHAT is or agreed upon), actually referred to in the text.

2. Theory Review

2.1 Cooperative Learning

According to Trianto, 2007, learning under the theory of constructivists is cooperative. Cooperative learning emerge from the concepts that the students will more easily find and understand difficult concepts if they discuss with friends. Students routinely work in groups to help each other solve issues that are complex. So the nature of the social and the use of peer group a key aspect of cooperative learning. According to Sugiyanto, 2010, cooperative learning (cooperative learning) is a learning approach that focuses on on the use of small groups of students to work together to maximize the learning conditions for achieving learning goals. According to Lie (in Sugiyanto, 2010), in cooperative learning there are several elements that must be known. These elements are: (1) the interdependence is positive, (2) face to face Interaction, (3) Accountability of the individual, (4) Skills to establish personal relationships.

2.2 Steps of Cooperative Learning

There are six main steps or stages in a lesson using cooperative learning. Phase 1, the lesson begins with the teacher convey the objective of the lesson and motivated students to learn. Phase 2, the teacher conveys information, often times the reading material rather than verbally. Phase 3, students are grouped into teams-team learning. Phase 4, teachers guide students work together to complete the task with them. Phase 5, the percentage of results end of working group or evaluation about what they have learned. Phase 6, the teacher gave the award to the efforts of groups and individuals.

2.3 Module

According to Mulyasa (2004:148) module is a learning process for a unit subject specific which are arranged in a systematic, operational and targeted to be used by the students, accompanied by guidance on its use to teachers. Learning with the module system has the following characteristics: (1) Each module must provide information and give instructions for implementation are clear about what should be done by the learners, how to do it, and a source of learning what should be used. (2) a Module is a learning individual, so seek to involve as much as possible the characteristics of the learners. (3) the learning Experience in the module is provided to help learners achieve the learning objectives effectively and seefesien possible, as well as allow the learners to do learning actively, not just read and hear, but more than that, the module provides the opportunity to role-play (role playing), simulation and discussion. (4) the learning Material is presented logically and systematically, so that learners will know when they start and when the end of a module, and does not pose the question about what should be done or studied. (5) Every module has a mechanism to measure the achievement of the learning objectives of the students, especially to provide feedback/response for the students in achieving mastery learning.

2.4 Trainer

According to Hasan's (2006: 3) the trainer is a set of equipment in the laboratory is used as a medium of education which is a combination between a working model and a mock-up. Trainer indicated to support the learning of students in applying the knowledge/concepts acquired on real objects. The Model mock up is a simplification of the arrangement of the constituent parts of a process or system that is more complicated. From these statements it can be concluded, the trainer is learning media in the form of a replica or a miniature of a device that simulated and applied in practical activities in the laboratory/workshop that help and facilitate the students understand and master the learning material being delivered. According to Suryani (2006:5) some of the excess media trainer as a learning media are as follows: (1) Not all systems can be presented in the mathematical model, simulation is the appropriate alternative. (2) Can experiment without any risk on a system that is real, with the simulation allows to perform experiments against the system without having to bear the risk of the system running. (3) the Simulation can estimate system performance under certain conditions and provide design alternatives to best fit with the desired specifications. (4) the Simulation allows to perform long-term studies delam a relatively short time. (5) Can use the input data varied. (6) is a concrete and more realistic in the bring up subject matter, if compared with verbal language. The Media trainer also has a weakness as a medium of learning, according to Suryani (2006:5), namely: (1) the Quality and analysis model depending on the maker model of learning. (2) Only estimate the characteristics of the system based on certain input. (3) show Only the perception of the senses the eye, the size is only limited can be viewed by a group of students.

2.5 Servo Motor

Servo Motor is a DC motor with feedback system is closed in which the position of the motor will be informed back to the control circuit in the servo motor. A servo Motor is essentially a motor with special qualifications in accordance with the application "sevosing" in the control technique, consists of a DC motor, a series gear, the control circuit and the potentiometer. Servo Motor is widely used on the R/C (remote control) cars, planes, helicopters, and ships, as well as the actuators of the robot and drive on the camera.

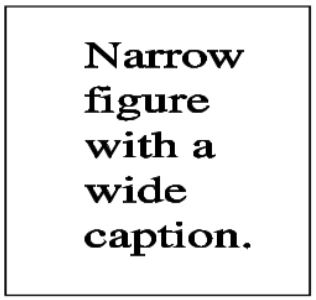

Figure 1. Servo Motor standar Hitec HS-311

As the name suggests, a servomotor is a servo. More specifically, is a closed loop servo that uses position feedback to control the movement and final position. Input control is some signal, either analogue or digital, representing the position commanded for the output shaft. Principle it works the motor is controlled with the signal modulisasi pulse width through the control cable. Pulse width control signal is given will determine the position of the angle of rotation of the shaft of the servo motor. Example, the width of the pulsation with a time of 1.5 ms (mill seconds) will rotate the motor shaft of the servo to an angle of 90. When the pulsation is shorter than 1.5 ms, then the shaft will re-spin to position 0 or to the left in a counter clockwise direction, whereas when the pulsation given longer than 1.5 ms, then the shaft of the servo motor will rotate to a position 180 can be seen in figure 2.

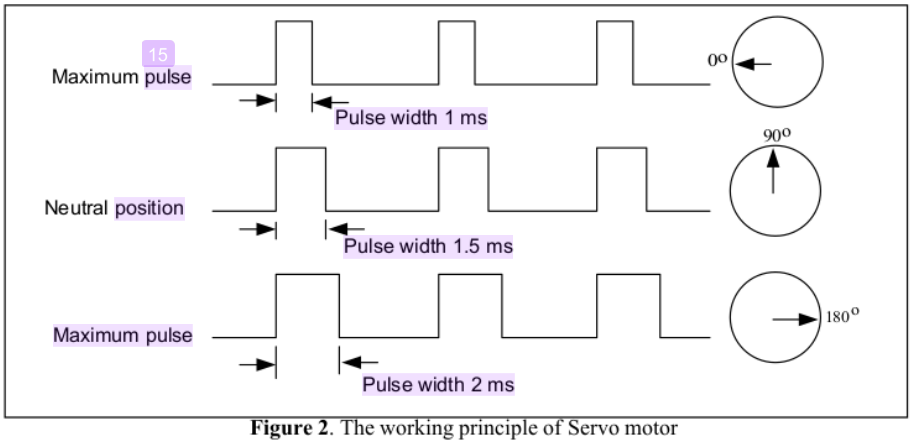

Figure 2. The working principle of Servo motor

When the width of the control pulse has been given, then the shaft of the servo motor that will move or spin toward a position that has been commanded and stopped in that position and will remain in that position. Such as if there is an external force to try to move, rotate or change the position by force, then the servo motor will resist and fight with the magnitude of the strength of the tors which has (rating torque servo). But the servo motor will not maintain its position forever, the signal width of the control pulse must be repeated every 20 ms once to remain instructed that the position of the motor shaft of the servo the remain or still hang on to his position.

3. Research Methods

This research type is development research using methods Research & development (R & D).This research is the product developed is a Software of Learning Practicum Servo Motor as a Supporting Lab for the Basic courses System Settings in the Department of Electrical Engineering, Faculty of Engineering, and Universitas Negeri Surabaya. According to Sugiyono (2015:409) there are ten steps of research R&D. However, in this study not used fully such measures, but modify the stages of his research only into six steps and is intended for the manufacture of products in the scope of small-scale and limited and not intended to mass produce its products. Thus, the six steps or the procedure of his research that have been modified are as follows. Stage 1 needs analysis learning device. Stage 2 Design the initial product. Stage 3 Validation of expert and revision. Phase 4 trial usage. Stage 5 Reporting and analysis. Stage 6 the results of the final product. Because the stages or the research procedures have been modified, then the procedure his research into like Figure 3 below.

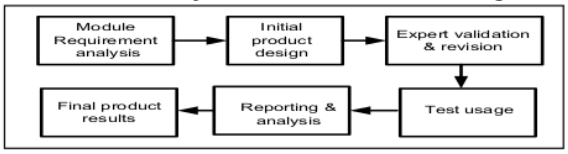

Figure 3. The modified step or procedure of the study

4. Validation of Expert and Revision

Validation of expert and revision is an activity that is intended to analyze and to test systematically the results of the product, namely the learning device. At the stage of validation performed two types of validation, i.e. the validation module and validation trainer. The validation module is intended to

provide input and evaluation regarding the content of the material in the modules in the learning device customized with the material taken is about the servo motor, while the validation of the trainer is meant to provide input and evaluation regarding the principal instrument in the module that is used as a function of learning media lab. Input and evaluation based on the results of the validation of the 3 expert/validator composed of experts in the substance, media experts and experts in pedagogy from the faculty of Electrical Engineering, Universitas Negeri Surabaya.Such a result is expected to find flaws and shortcomings in the learning device. Then do the revision on the product which is prepared by fixing the weaknesses and shortcomings of the product until the product is really worth to test.

5. Results and Discussion

5.1 Module validation results

On the instrument the Validation of the Lab Module, there are 4 indicators assessed by the validator, i.e. the Physical Trainer, Discussion, Grammar, Size and Shape of the Letters. As for the recapitulation of the results of the calculation of the validation module is shown in Table 1.

Table 1. Recapitulation Of The Results Of The Validation Lab Module

Indicators	Assessment Criteria				∑ validator value
	1	2	3	4	
Physical Module					
The attractiveness of the face cover				3	12
Contains elements of the title				3	12
Contains the name of the author				3	12
Contains the name of the university				3	12
Load the logo of the university				3	12
The cover image is interesting				3	12
Discussion					
The material in accordance with the RPS			2	1	10
Image in accordance with the content of the material.			1	2	11
The text can be read clearly.			1	2	11
The instructions on the module help			2	1	10
The task of encouraging active student learning.			3		9
The task encourages students to think critically.			3		9
The level of truth the concept of the material in the module.			3		9
Text and image are interrelated			2	1	10
. Object image according to the material.			2	1	10
Object the image is clear or not blurred			3		9
Grammar					
Language in accordance with EYD.				3	12
The language is easy to understand.			1	2	11
Not many use the term regionalism				3	12
Not many using a foreign language				3	12
The language used in accordance with the intellectual			1	2	11

Indicators	Assessment Criteria				∑ validator value
	1	2	3	4	
development of students.					
Size and Letters					
The size of the font proportional and can be read.			1	2	11
The length and width of the modules have already considered.			1	2	11
The size of the letters according to the rules.			1	2	11
Do not use letter models				3	12
Total					237

Based on Table1, the result of validation of the module to the whole indicator on the module validation sheet obtained by the total score is 273, and to know the validity level of the module it is known that the average is calculated by the formula:

$$\text{Average score} = \frac{\Sigma \text{answer validator}}{\Sigma \text{validator x} \Sigma \text{item}} = \frac{273}{3 \text{ x } 25} = 3{,}64$$

Based on the calculation of the formula, the average is 3.64 and when viewed based on the interpretation table the score is at interval> 3.25 s / d 4 that is included in the criteria "Very Valid". Based on the results of the overall assessment can be concluded that the module "Very Valid" and its meaning is very applicable for research in the Department of Electrical Engineering State University of Surabaya.

5.1.1 Trainer Validation Results

In the Trainer Validation Instrument, there are 3 aspects that are evaluated with the total details of the 15 different aspects assessed by the validator namely Media Compatibility with Curriculum, Display and Media Quality, Media Compliance with Module Practicum. The recapitulation of Trainer validation results is shown in Table 2.

Table 2. Recapitulation of Trainer Validation Results

No	Rated aspect	Assessment				∑ validator value
		1	2	3	4	
Media Suitability with Curriculum						
1	Media trainer in accordance with the teaching materials delivered			2	1	10
2	The making of trainers helps the understanding of the material presented				3	12
Display and Media Quality						
1	Design trainer.			1	2	11
2	The suitability of the box trainer size with the circuit.			1	2	11
3	The layout of the circuit on the trainer.			2	1	10
4	Picture clarity / circuit scheme on the trainer (description of component symbol and part name of each circuit.			1	2	11
5	The writings on the trainer read clearly.			1	2	11
6	The accuracy of wiring-point layout (cabling place)			1	2	11
7	Length of the connector cable as needed.			1	2	11
8	Ease of connecting connectors on the trainer.			1	2	11
9	Easy access to each circuit.			2	1	10
10	Performance trainer.			3		9
11	Ease of operation / use of trainer			3		9
Media Conformity with Jobsheet						
1	Conformity of trainer with module material.			2	1	10
2	Practical activities with trainers in accordance with the module.			3		9

Based on Table 2 the results of Trainer validation recapitulation on all aspects of the trainer validation sheet obtained the total score is 156, and to know the level of validity of the learning device it is necessary to know the average is calculated by the formula:

$$\text{Average score} = \frac{\Sigma \text{answer validator}}{\Sigma \text{validator x } \Sigma \text{ item}} = \frac{156}{3 \text{ x } 15} = 3{,}47$$

Based on the calculation of the formula, it is obtained averages of 3.47 and when viewed based on the interpretation table scores are in the interval> 3.25 s / d 4 that is included in the criteria "Very Valid". Based on the overall results of the assessment can be concluded that the trainer "Very Valid" and its meaning is very applicable for research at the Department of Electrical Engineering State University of Surabaya.

5.1.2 Limited Trial

After going through the stage of validation, then do a revision on the product as per the advice of the validator. Then it is tested limited to ten students of the Department of Electrical Engineering study program S1 TE class of 2014. Trial usage was done with the aim to determine the response of the students. So it is expected after a trial use of this learning device is able to determine the feasibility as Supporting Media Practicum for courses the Basic System Settings in the Department of Electrical Engineering, Faculty of Engineering, Universitas Negeri Surabaya, as well as the material is lifted and presented in accordance with what is required of the students of the Department of Electrical Engineering State University of Surabaya.

5.2 Results of Student Response

In the Student Response response validation instrument, there are 2 indicators assessed by the validator of the instruction, and the language. The recapitulation of Student Response validation calculation results is shown in Table 3.

Table 3 Recapitulation of Student Response Selection Validation Results.

Indicator	Assessment				∑ validator value
	1	2	3	4	
Construction					
The statement is formulated briefly (not with 20 words) and clear.			2	8	38
The sentence is independent of the irrelevant statement of the object in question or the sentence is a necessary statement only.			3	7	37
The sentence is free of double negative statements.			1	9	39
The sentence is free from statements referring to the past.			4	6	36
The sentence does not contain elements that harm the other side.			3	7	37
The sentence is free from factual statements or can be interpreted as facts.			5	5	35
The sentence is free of statements can be interpreted more and free of statements that may be approved or vacated by almost all respondents.			3	7	37
Each statement contains only one complete idea.			4	6	36
Sentence does not contain any questions.			1	9	39
The sentence is free of uncertain statements like all, always, sometimes, none, never.			4	6	36
Do not use words a lot, just, just.			3	7	37
Use as necessary			3	7	37
Grammar					
Language problem should be communicative and in accordance with the level of education of students or respondents.			1	9	39
The matter should use standard Indonesian.			2	8	38
Problem not using local / taboo language.			2	8	38
Total					559

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Based on Table 3, the result of the recapitulation of validation of student response questionnaire to the overall indicator on the validation sheet of student response questionnaire obtained total score is 559, and to know the level of validity and Questionnaire response need to know the average is calculated by the formula:

$$\text{Average score} = \frac{\Sigma \text{answer validator}}{\Sigma \text{ validator x } \Sigma \text{ item}} = \frac{599}{10x15} = 3{,}73$$

Based on the calculation of the formula, it is obtained the average of 3.73 and when viewed based on the interpretation table scores are in the interval> 3.25 s / d 4 that is included in the criteria "Very Valid". Based on the results of the overall assessment can be concluded that Questionnaire Response "Very Valid" and its meaning is very applicable for learning at the Department of Electrical Engineering State University of Surabaya.

6 Conclusions and recommendations

6.1 Conclusions

The conclusions gained from this study are the validity of learning tools obtained based on validator assessments when all aspects are validated. Based on the score analysis obtained based on the validator value, it is known that the validity value of the practicum module is 3.64; Trainer Motor Servo is 3.47; Questionnaire Response is 3.73. With the overall validation value is in the interval> 3.25 s / d 4 with the category of "Very Valid", so it can be concluded that all products have a validity level and "Very Valid" so it is worthy to be used for learning Basic courses of System Settings.

6.2 Recommendations

The use of existing Trainers in the laboratory needs to be optimized so that students get a long-term learning experience. The tools used in this study are considered to be valid enough even very valid for use in learning in the next year with the same material.

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