

Teaching Aid Development of Electropneumatic Based Automation Course

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Abstract—To conduct the entertaining and attractive activities on learning process, therefore the design of valid and practical teaching aid and its implementation on electro pneumatic based automation course is presented in this paper. An electro pneumatic sorting machine with Programmable Logic Controller (PLC) based automation is designed as a teaching aid to existing teaching and learning process, and to achieve the learning outcomes towards enhancing the student's knowledge and hands-on skill. The Development Research Method is applied to develop the existing electro pneumatic didactic trainer device. Validation stage is held to confirm that proposed teaching aid. Validator involves the expert lecturer on relevant field, meanwhile the practicality is measured by lecturer and students of course participants. Based on the survey, the respondents are strongly agree that 92,6 % and 94,8 % of proposed teaching aid are valid and practical respectively. Furthermore, the results claimed that using the proposed teaching aid there is improvement in the electro pneumatic course learning process.

Keywords—development research; electro-pneumatic; sorting machine; teaching aid

I. INTRODUCTION

Learning Outcomes achievement is crucial issue in teaching process. However, there are several classical problems in study activities such as less of attractive and entertaining. Teacher as fasilitator should be have ability to encourage the students on develop and improve knowledge, hands-on skill, attitude and creative idea to get the qualified graduates [1]. Therefore, to realize the aferomentioned learning condition then using the teaching aids must be involved. Taching aids are defined as all physically tools or equipments that can be used to delivery the lesson materials including text books, miniature, prototype, dummy object and all multimedia devices [2].

PLC (Programmable Logic Controller) and Pneumatic Course (Code: ELO1.61.5201) is one of subject lectures on Electrical Engineering Education of Universitas Negeri Padang that discuss the industrial automation topic. The existing learning activities are using the Festo didactic electropneumatic trainer as teaching aids especially in experimental. According to survey and observation results there are some problems are found regarding to limitation of the existing teaching aids. The existing didactic trainer only able to be used to describe the general concept of electropneumatic component. However,

towards improvement of students' understanding of real application of electropneumatic component on PLC based automation, then the existing didactic trainer is developed as proposed teaching aid. The same electropneumatic components as existing didactic trainer are applied on PLC based automatic sorting machine. Its a challenging to bring the real industrial automation equipment system to calssroom and vise versa. Therefore, teaching aid that can be described and modeled the industrial automation machines are needed.

Several studies related to teaching aid development are reported; Microcontroller teaching aid was developed and applied on microprocessor course in same departement, the results claimed that the developed teaching aid are 89% valid and 92% practice respectively [3]. Another Teaching aid on PLC operational topic was developed for vocational high school the result reported 97% valid and 84% practice [4].

II. METHOD AND RESEARCH PROCEDURES

The research development method is applied in this study. The proposed method is used to create and investigate the effectiveness of product especially for didactic and learning activity [5]. The resesarch procedures include the data collection, planning, product drafting, preliminary field, main revision, main testing, operational revision, operational testing, final revision and implementation as shown in figure 1. Both preliminary and operational testing are discussed as main analyze in this study. The product is validated on preliminary field testing on this stage two expert validator are involved. Furthermore, the product is revised based on validator suggestions.

The validation stage is a process to assess the suitability of the teaching aid design with the PLC and Pneumatic course topics.

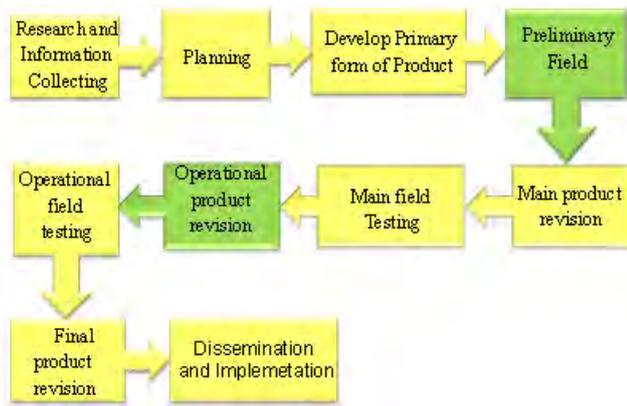


Fig. 1. The validation stage.

The validation of proposed teaching aid is carried out by offer two experts, each validator answers based on assessment questionnaire as validation sheet. If the result achieve the validation criteria, then proceed with final product, but the design will be revised according to the validator's suggestion instead. The validity level refers to experts and consisting of instructional lecturers of PLC and Pneumatics course. The validation score granting by equation (1).

$$Validation = \frac{Respondent\ Score}{Maximum\ Score} \times 100\% \quad (1)$$

Furthermore, a practical questionnaires are used to measure practicality level of the proposed teaching aid. The practical questionnaire refers to response of lecturers and students as teaching aid user. Indicator on practicality test based on: (1) user friendly (2) efficiency (3) easy to understanding (4) performance and (5) packaging [6]. The practical level is obtained from the score on existing and validated development research and adopted as design criteria as shown in equation (2).

$$Practical = \frac{Respondent\ Score}{Maximum\ Score} \times 100\% \quad (2)$$

Both of validation and practical questionnaire are filled out based on the grid using the Likert scale as follow: 5 = Strongly Agree, 4 = Agree, 3 = Neutral, 2 = Disagree and 1 = Strongly Disagree with average score 100 – 81, 80 – 61, 60 – 41, 40 – 21 and 20 – 0 respectively [6].

III. TEACHING AID DESIGN

The proposed teaching aid development focuses on using of pneumatic devices application in PLC and Pneumatic course. The fixed teaching aid was used the Festo electro pneumatic didactic trainer as shown in figure 2. In fact, this trainer is rarely used due to the impracticality, not described and modeled an industrial automation system and lack of attractive. Therefore, it is necessary to develop an electro pneumatic trainer as teaching aid that suitable to the subject requirement in this courses.

The design was simple but need more attention to fulfill aspects of function such as practicality, learning outcomes achievement and safety consideration. The proposed teaching aid for electro pneumatic trainer shown in figure 3.

The proposed teaching aid is designed as a sorting machine based on weight and using PLC as main controller. The design performance refers to learning outcome needs and adopt the problems solving activities in PLC and Pneumatic course. Figure 3 shows the proposed teaching aid design.



Fig. 2. The Fixed electropneumatic trainer (Festo didactic).

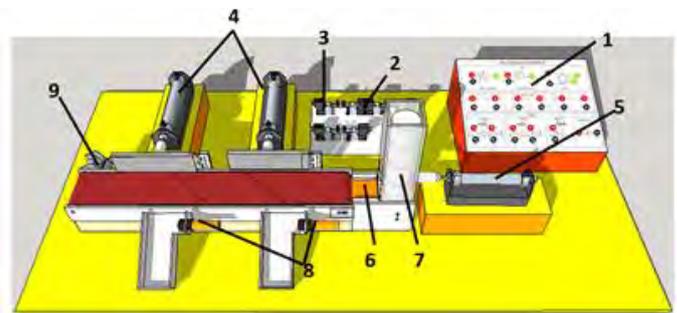


Fig. 3. Design of the propose teaching aid as sorting machine PLC-pneumatic based automation.

The parts shown in Figure 3 can be listed as (1) Connector panel (2) 5/2 valve (3) 3/3 valve (4) double acting cylinder (5) single acting cylinder (6) loadcell weigh scaling table (7) object slot (8) proximity sensor and (9) 12 DC motor belt conveyor drive respectively.

The sorting activities are refer to weight variation with the similar shaping and sizing. First, object is fed to weigh scaling table by feeding cylinder activation. Second, object weigh is measured by loadcell and its controller module. Finally, Each 150gr and 250gr object will be separated into two groups using pneumatic cylinder activation (part no. 4) for driving the trapper bar.

IV. RESULT AND DISCUSSION

After following all stages of research in the form of aferomentioned development research, the final product of teaching aid used in lectures. The overall of final product is presented on figure 4. For pneumatic cylider and its solenoid valve directly adopt the part of fixed Festo didactic component. Trapping bar is made from light alluminium sheet and the other casing made from acrylic. All terminals in panel is connected by banana plug within 24 Vdc operational voltage.



Fig. 4. The overall final product of teaching aid for PLC-electropneumatic based automatic sorting machine system.

The proposed teaching aid must be achieved the valid and practical characteristic according to validation and practical questionnaire by the expert participants as shown in table 1.

TABLE I. VALIDATION QUESTIONNAIRE RESULTS

No	Validator	Score	Percent.	Classification
1	Validator 1	48	96%	Strongly Agree
2	Validator 2	49	98%	Strongly Agree
3	Validator 3	42	84%	Strongly Agree
Average			92,6%	Strongly Agree

Table 1 revealed that validation sheet is validation process carried out by three validators and the results shows that electro pneumatic teaching aid was categorized as very valid, and the results of validity tests performed by the validator revealed that the trainers developed were in according with contents and objectives in PLC and Pneumatic course. The results of this validation certainly meet the requirements or consideration in choosing the appropriate teaching aid for PLC and Pneumatics course activity, such as conformity with learning competencies, trainer characteristics developed, time allocation and technical quality of the teaching aid.

TABLE II. PRACTICALITY QUESTIONNAIRE RESULTS BY LECTURER

No	Lecturer Resp.	Score	Percent	Classification
1	Respondent 1	42	84%	Strongly Agree
2	Respondent 2	44	88%	Strongly Agree
Average			86%	Strongly Agree

Therefore the research product for the development of electro pneumatic trainers has been meet criteria in media selection and can be used as teaching aid in PLC and Pneumatic course. The results also shows that with using the

proposed teaching aid can make students more active, more independent, as well as providing motivation and stimulation of learning for college student. Therefore electro pneumatic teaching aid also fulfilled criteria as a teaching aid media according to didactic purpose.

After the validity test results are obtained, the next step in development research is a practical test refers to user friendly principle. Not only improve students' motivation and interest, the proposed teaching aid also help students to improve the understanding, present data with interest and reliable, facilitate data interpretation, and compact information. Therefore the practical test of the teaching aid aims to determine the level of user friendly even by teachers and students as the user. Practical testing is done by distributing questionnaires practicality to both respondents. Respondents in the practicality test are two lecturers PLC and Pneumatics course and 10 attendant students as presented in table 2 and table 3. The practical test results show that proposed teaching aid meet the criteria practical to be used as a media in PLC and Pneumatics course in Electrical Engineering Departement of Universitas Negeri Padang.

TABLE III. PRACTICALITY QUESTIONNAIRE RESULTS BY STUDENT

Student resp.	Score	Percent	Classification
1	48	96%	Strongly Agree
2	43	86%	Strongly Agree
3	49	98%	Strongly Agree
4	49	98%	Strongly Agree
5	46	92%	Strongly Agree
6	48	96%	Strongly Agree
7	48	96%	Strongly Agree
8	48	96%	Strongly Agree
9	49	98%	Strongly Agree
10	46	92%	Strongly Agree
Average		94,8%	Strongly Agree

V. CONCLUSION

Based on the survey, the respondents are strongly agree that 92,6 % and 94,8 % of proposed teaching aid are accomplished the valid and practical requirements respectively.

The results revealed that using the proposed teaching aid there is improvement in the electropneumatic course learning process.

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