Develop of Control Water Supply Pump Based on *Supervisory Control and Data Acquisition* on Instrumentation and Power Generator Control in Grade X Students Majoring In Electric Power in the PGRI 3 Vocation School Malang

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**Abstract.** The quality of education can affect the quality of the learners were produced. The importance to improve the quality of education so learners produced increased anyway. According to Asyhar, one way to improve the quality of education is the use of media of instruction. Instrumentation and generator control the Generator operation of SCADA on power plant aims to train students designing and mengoperasikan the existing SCADA system at the power plant. One operation of SCADA in electricity generation at the WTP (Water Treatment Plant), namely on Water Supply Pump to control water pump. SCADA learning media packed in prototype trainer Water Supply Pump -based Supervisory Control And Data Acquisition SCADA learning to support. Aiming to understand the way design of SCADA, create, communicate, SCADA program and operate it. The model used is the development model of development Sugiyono. Stages of development model Sugiyono are: (a) the potential and problems, (b) data collection, (c) product design, (d) design validation, (e) the revised design, (f) a trial product, (g) product revision, (h) a trial use, (i) the revision of the product, and (j) production mass. The results of the research and development shows that the eligibility level trainer control water supply pump has a percentage of 91.9% of the 3 (three) validator experts which means decent products used with little revision, 83.72% of test small groups by 10 (ten) grade X PBB meaning decent products used without revision, 90.53% of tests by a large group of thirty (30) students of class X PBA product which means it is very worthy of being used without any revisions. The conclusions of this research and development are decent products used in the learning process. The product can help learning activities can help so that the students of class X students majoring in electric power can be better understand the operation of scada in electricity generation units.

1. **Introduction**

From UU RI No. 20 on year 2003 about education national system article 1 paragraph 1 is conscious and planned effort to realize the process learning for students develop their potential and skill that benefit themselves and the community. With this education have skill and to be competent human resource. This can be achieved if the quality of education is good. According of Rayandra Asyhar (2012) to upgrade the quality of education can be use instructional media. The facility and infrastructure educational is instructional media that important to be considered. Especially in the vocation school
instructional media support to train students skill. Vocation school used the power point, video, and others of instructional media first.

Vocation school PGRI 3 of Malang have several technical fields of expertise, from Electrical engineering and technical informatics, Mechanicakal engineering, Otomotif Engineering. In Electrical engineering and technical informatics have a Power Plant class that prepare someone expert in the field of Power Plan Engineering. On Power Plant class the subject Instrumentation and Control Power Generator is taught in accordance with the existing curriculum. Subject Instrumentation and Control Power Generator related to Supervisory Control and Data Acquisition. According to Amar (2012) Supervisory Control and Data Acquisition is a system that can control, supervise, retrieve and record data paragraphs are.

The observations I made on November 22, 2018 through interviews with teacher of these subject. Student’s knowledge of the Instrumentation and Control subjects is already good and outcomes obtained with average value meeting the graduation standard. However, it was stated by teacher that skill of student in the field of operating SCADA, which is one of the skill learned in the Instrumentation and Control subjects is still low. Because the media used so far only use instructional media in the form of power points. So anything instructional media that supports. Therefore, it is necessary to develop a trainer to train SCADA operating skills. The trainer needs to be designed according to the main material listed in the instrumentations and control syllabus, which is installation of control units based on SCADA. The subject matter explain the use of the SCADA for control of power plant equipment. So that trainer developed is a water supply pump control using SCADA.

Trainer of control water supply pump using SCADA will using students for practice. The trainer is important as a media to train student’s skill in designing SCADA from the start and communicating it with a water supply pump trainer. After successfully communicating the SCADA with the RTU device in the form of Arduino. Student can practice SCADA skills for control, supervision, retrieval and recording of data on the water supply pump trainer.

2. Development Method
This research and development is useful for developing products that can be used to support the practical learning process in the subjects of Generator Instrumentation and Control. This water supply pump control trainer can be used to support practical learning operations on the generator unit. The use of instructional media makes it easier for students to understand the operation in the generating unit because students will make it from the beginning of the display to connecting to the trainer first.

The research and development model used to develop the product is Sugiyono's research and development model. The model was chosen as the basis for developing the trainer's products because the steps were systematic in accordance with the needs to be used, as well as good and flexible rules to be used to develop a water supply pump control trainer.

Sugiyono’s research and development model consists of 10 steps, namely: (1) Potential and problems; (2) Data collection; (3) Product design; (4) Design validation; (5) Design revisions, (6) Product trials, (7) Product revisions, (8) Usage trials, (9) Product revisions, (10) Production.
2.1. Product Design
The product design developed was divided into 2, which is design of Control Water Supply Pump in PLTGU using SCADA trainer and jobsheet design. The product design is as follows:

2.1.1. Trainer Design

![Figure 2. Water Supply Pump Trainer](image)

Figure 2. Water Supply Pump Trainer

The trainer measures 103cm in length, 54.5cm in width, and 45cm in height with plastic tanks, Arduino, flow water sensors, water level sensors, terminal blocks, relay modules, indicator lights, and mini water pumps. There are 3 plastic tubes with a volume size of 400cm³ for the tank, with tanks A and B, while 750cm³ for demanding the WTR tank CCPP. The Arduino used is Arduino Uno as the device. The flow water sensor consists of 3 pieces placed on 3 channels, the first channel that leads to the demin tube, the ccp water tank, the second channel from the condensate transfer pump, and the third channel from the demin water transfer pump. Water level sensors that will be placed in each tank which number 3. The relay module used contains 4 channels and consists of 2 relay modules. The indicator light is red as many as 7 and the indicator light is green as many as 7. Mini pumps are 7 pieces with a voltage of 6-12 VDC.

2.1.2. Jobsheet Design

In development research, jobsheets will also be created to support practical learning activities. The design of the worksheet consists of several points in it such as: (1) title, (2) objectives, (3) Basic theory, (4) tools and materials, (5) work safety that must be considered, (6) experimental steps, (7) experimental results, (8) data analysis, and (9) conclusions, (10) problem training.

2.2. Validation and Trial Techniques

The validation and trial or product evaluation techniques in this research and development are carried out in 3 (three) stages, that is product validation by experts, small group trials and large group trials. The results of the validation and trial are intended to data collect related to a lack of teaching materials. The three stages are explained as follows.

2.2.1. Expert Validation

In the product validation stage, the experts involved 3 (three) validators, they were TE UM lecturers and teachers in the Power Generation Vocational School PGR 3 Malang as reviewers. This evaluation aims to assess the appropriateness of the contents, whether or not the contents are relevant to the learning objectives, and the quality of teaching materials before being tested on students. After validating the product by the expert, then the product is revised to the errors that have been found. Data collection instruments in this evaluation used a questionnaire.
2.2.2. Small Group Trials
The small groups evaluate to find out the feasibility of the water supply pump control trainer product by selecting 10 (ten) class X PBB students who have taken the subject matter contained in the basic competencies of the Plant Instrumentation and Control subjects. Through this trial can be known quality, products interesting and identify problems that may arise. Data collection instruments in this evaluation used a questionnaire.

2.2.3. Large Group Trials
A large group trial was conducted to determine the feasibility of the learning media that had been made involving 30 (thirty) PBA class X students. The purpose of this evaluation is to determine the feasibility of the product. Data collection instruments in this evaluation used a questionnaire.

2.3. Data Collection Instruments
The evaluation instrument for testing validity or feasibility of teaching materials uses a questionnaire. Product feasibility test questionnaire contains material assessment and media assessment. Before being used, product validity questionnaire was validated by the research supervisory.

Material and media assessment instrument lattices are used as guidelines for the preparation of the research questionnaire. Through a research questionnaire that will be filled out by validator I, validator II, validator III, students of small group trial subjects and large group trial students can find errors from the products that have been developed. Thus it can correct errors so that the product that the researcher develops can be used for learning activities in Instrumentation and Control Generators.

Products that are assessed on the media eligibility assessment consist of: (1) Trainer; (2) Software; (3) Manual books; and (4) jobsheet. Questionnaire grids for assessing the feasibility of instructional media are shown in Table 1. Assessing the feasibility of instructional media.

| No | Product | Indicator | Source |
|----|---------|-----------|--------|
| 1  | Trainer | The writing on the Trainer can be read and understood | Wahono, 2006 |
|    |         | Simple and attractive trainer |        |
|    |         | Reliable Trainer | Arsyad, 2013 |
| 2  | Software| Efficient and effective trainer in use | Wahono, 2006 |
|    |         | Easy to use Trainer |        |
|    |         | Simple software in operation |        |
| 3  | Jobsheet| Easy to use software | Wahono, 2006 |
|    |         | Reliable software |        |
|    |         | Clarity of steps in the jobsheet | Wahono, 2006 |
|    |         | Use of standard language in the jobsheet |        |
|    |         | Image is clear |        |
|    |         | The text on the jobsheet is clear |        |
| 4  | Manual Book | The language used is standard | Wahono, 2006 |
|    |         | Image is clear |        |
|    |         | The text on the manual book is clear |        |

Products that are assessed on the media eligibility assessment consist of: (1) Trainer; (2) Manual books; and (3) jobsheet. Questionnaire grids for assessing the feasibility of material are shown in Table 2. Questionnaire grids feasibility of material.
Table 2. Questionnaire grids feasibility of material

| No | Product | Indicator                                                                                           | Source       |
|----|---------|-----------------------------------------------------------------------------------------------------|--------------|
| 1  | Trainer | Trainer In accordance with the objectives to be achieved                                           | Arsyad, 2013 |
|    |         | Trainer in accordance with KD / Curriculum                                                          |              |
|    |         | The writing on the Trainer can be read and understood                                              | Wahono, 2006 |
| 2  | Jobsheet| The suitability of the material with the jobsheet                                                   | Arsyad, 2013 |
|    |         | The suitability of the material with the objectives on the jobsheet                                |              |
|    |         | The depth of the jobsheet is in accordance with the level of student development                   | Akbar, 2013  |
|    |         | The presented of material in the jobsheet is according to scientific truth (actuality)            | Wahono, 2006 |
|    |         | The presented of material in the jobsheet is in accordance with the latest developments (contextual) |              |
|    |         | Jobsheet presents learning objectives                                                              | Akbar, 2013  |
|    |         | Jobsheet presents material description                                                              |              |
|    |         | Jobsheet presents work steps                                                                          |              |
|    |         | Jobsheet presents assignments                                                                         |              |
| 3  | Manual Book | Use standard language                                                                                  | Wahono, 2006 |
|    |         | Accuracy in structuring sentences in the jobsheet                                                    |              |
|    |         | The size of the writing on the jobsheet is suitable so it is easy to read                           |              |
|    |         | Use standard language                                                                                  |              |
|    |         | The writing is clear and legible                                                                     |              |
|    |         | The relevance of information conveyed with purpose                                                  |              |

Making a research questionnaire using 4 (four) levels of assessment according to Rating scale. Table 3 shows the assessment level criteria in the questionnaire for media experts, material experts and students using Rating scale (Sugiyono, 2016: 135).

Table 3. Skala Likert

| No | Number | Qualitative Meaning                                                                                     |
|----|--------|--------------------------------------------------------------------------------------------------------|
| 1  | 4      | The subject matter is very good / very decent / very interesting / very appropriate / very clear.       |
| 2  | 3      | The subject matter is quite good / decent enough / interesting enough / quite appropriate / clear enough.|
| 3  | 2      | Sub subject is not good / not suitable / less attractive / not suitable / less clear.                   |
| 4  | 1      | The subject matter is not very good / very improper / very unattractive / very unclear.                |

2.4. Data Analysis

The type of data obtained from this development research is in the form of qualitative and quantitative data. Qualitative data in the form of responses, comments, criticisms, suggestions and recommendations about the product by validator I, validator II, validator III and students of the test subject are written in the suggestion box on the final sheet of the trainer validation questionnaire. While quantitative data were obtained from questionnaire scores given by test subjects. To determine the appropriateness of the trainer developed by conducting an evaluation or trial. The initial step is by finding the percentage score obtained through the results of the product validation test questionnaire, which is by formula 1.

\[ V = \frac{T_{se}}{T_{sh}} \times 100\% \] (1)
Information:
V = Validity (feasibility)
Tse = Total empirical score
Tsh = Expected maximum total score

After knowing the results of the percentage of the questionnaire, then grouping into the trainer eligibility criteria shown in Table 4, Feasibility Criteria.

Table 4. Feasibility Criteria.

| No. | Value Scale (100%) | Information |
|-----|-------------------|-------------|
| 1.  | 85,01% - 100,00%  | Very valid, or can be used without revision. |
| 2.  | 70,01% - 85,00%  | Quite valid, or can be used but needs minor revisions. |
| 3.  | 50,01% - 70,00%  | Invalid, it is recommended not to be used, it needs a big revision. |
| 4.  | 01,00% - 50,00%  | Invalid, or may not be used. |

3. Discussion Result
3.1. Product Manufacture Results
The results of this product development in the form of a control water supply pump trainer, manual books, and job sheets for class X students majoring in Electric Power Manufacturing. This trainer is intended for practicum scada operation. After the product is finished being made, then the product is validated by 2 (two) TE UM lecturers and 1 teacher majoring in Electric Power Generation Vocational School PGRI 3 Malang who are competent to know the product validity.

After passing the product validation stage by the expert, the product trial phase is continued in a small group involving 10 (ten) grade X PBB students who are taking the Generating Instrumentation and Control subjects. The 10 (ten) grade X PBB students will use the trainer developed by the researcher, then the students fill out a research questionnaire. Through the research questionnaire, the researcher can find out the feasibility of the product being developed.

The next trial was a large group trial involving 30 (thirty) students of class X PBA. At this stage a demonstration of the use of a water supply pump control trainer was developed. After that students fill out a questionnaire to determine the level of product feasibility and student response after using the trainer that has been developed.

3.2. Product Feasibility Test Results
Presentation of data in this research consists of data: (1) the results of individual trials; (2) results of small group trials; and (3) results of large group trials. Individual trials are conducted by 3 (three) expert validators, that is TE UM lecturers and Power Plant majors teachers to test the feasibility of teaching materials. While the small group trial was conducted by 10 (ten) grade X PBB students who were taking the Instrumentation and Control subjects, this trial was conducted to see how feasible the product had been validated by the expert and improved according to expert advice. The final test is a large group trial that aims to find out the level of product feasibility when used in learning activities. Research subjects in large group trials were students of class X PBA.

Based on the data obtained, the final results of the percentage of eligibility for validation by experts of 91.9% obtained an average percentage of validator I, validator II, and validator III. The final result of the feasibility percentage in small group trials is 83.72% and the last average eligibility percentage from the results of large group trials is 90.53%. The results of the validation are shown in Figure 3.
4. Conclusion
Research and development of Trainer use research and development Sugiyono have 10 (ten) stage is:
(1) Potensial problem; (2) Data collection; (3) Product design; (4) Validation design; (5) Design revision; (6) Trial Product; (7) Product revision; (8) Usage product; (9) Product revision; (10) Production. Beside on data result, on result persentase of expert validation product is 91.9% obtained average persentase from validator I, validator II, dan validator III. The result from small group of trial persentase appropriateness is 83.72% end then average on big group of usage persentase is 90.53%. The conclusion trainer to lecture is appropriates.

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