The Development of Analog and Digital Trainer Base on Arduino Uno in Microprocessor Programming Subjects

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Abstract. Based on observations in vocational schools, it was found that schools rarely had companion media in analog and digital learning, especially during the pandemic, students were not allowed to go to school. A media trainer is needed that can explain easily to students. The purpose of this research is to make analog and digital trainers based on Arduino Uno in microprocessor programming subjects, that are expected to solve these problems. The research method uses Research and Development (R&D) has 7 stages: (1) the potential and problem analysis stage, (2) the data collection stage, (3) the product design stage, (4) the product validation stage, (5) the product revision stage, (6) product trial phase, (7) data analysis and reporting stages. From the experimentation of making analog and digital trainers, the results obtained validation of the use of trainer assessment of 84.37%. It can be categorized as very valid as a companion media in learning. The validation of the use of job sheets is also categorized valid with a value of 81.6%. The overall results of students in responding to this trainer as a companion in learning were very good, 88.49%. So it can be concluded that an appropriate media can assist students in learning without the teacher, while based on validation and response states this media is valid and suitable to be used as a companion media in learning microprocessor programming. This trainer is recommended to be a learning medium for students with an explanation from the teacher to understand analog and digital material.

Keywords: analog and digital trainer, Arduino Uno.

1. Introduction

Education is a way or process of learning the knowledge, skills, and behavior of a group of people who have been passed down from one generation to the next through the teaching process, training, and research [1][2]. One of the successes of Education is evidenced by an increase in student achievement and innovation from the instructor itself [3][4][5]. In general, learning media are also said to be aids in the teaching and learning process. Things that can affect feelings and attention as well as abilities and skills can be used as a learning process by learners. Examples of types of instructional media, including[6]: 1) Visual media: graphics, charts, posters, cartoons, diagrams, comics, charts. 2) Audial media: tape recorder, language laboratory, radio, and the like. 3) Projected still media: slide: overhead projector (OHP), in focus, and 4) Projected motion media: video (VCD, DVD, VTR), film, television, computer, and the like.
Based on observations at the State Vocational High School (SMKN) 2 Surabaya Audio Video material is a subject with a lack of instructional media, so there must be the development of several learning media as learning tools in schools. Examples of subjects in the Audio Video Engineering major who do not yet have media are Microprocessor Microcontroller Programming Techniques subjects. Trainer the application of analog and digital. Arduino Uno is very useful as a tool that can be learned to support analog and digital [7][8] learning of microprocessor programming techniques. Tools such as trainers that can guide students to learn independently with or without teachers with practice modules are needed. The superiority of the Arduino Uno-based analog and digital application trainer which has components such as Arduino Uno, LM35 temperature sensor, potentiometer, ultrasonic sensor, push button, LED (light-emitting diode), 16x2 LCD, DC motor and buzzer [8].

2. Method

There are 10 stages of Research and Development Method in this research, namely 1) the potential and problem stage, 2) the data collection stage, 3) the product design stage, 4) the design validation stage, 5) the usage trial stage, 6) the product revision stage, 7) the product trial stage, 8) the design revision stage, 9) the product revision stage, 10) the mass production stage, as shown figure 1.

![Research and Development (R&D) steps](image)

In this study, the implementation of the Research and Development method only reached the 7 (seven) stages where the last stage was analysis and reporting. With the following stages of research, This stage is summarized into 7 stages: 1) the potential and problem analysis stage, 2) the data collection stage, 3) the product design stage, 4) the product validation stage, 5) the product revision stage, 6) the trial phase product, 7) data analysis and reporting stage. The validation results were obtained from 7 expert validators.

Data collection using the validation method with the trainer validation sheet and the job validation sheet, in this study using data analysis techniques from the results of validation by the validator and the results of student responses. The data collection technique was interview, validation, questionnaires, and tests. Interviews were conducted to obtain information directly from Multimedia teachers. The following ranking scale is used as a ranking analysis and calculation, shown in table 1.

| No. | Media Quality Table |
|-----|---------------------|
|     | Percentage         | Interpretation Rating |
| 1   | 81-100%            | Very Valid            |
| 2   | 61-80%             | Valid                 |
| 3   | 41-60%             | Valid                 |
| 4   | Only21-40%         | Less                  |
| 5   | 0-20%              | Invalid               |

Determination of the highest validator/answering value, namely by means and formulas:
Table 2. The respondent questionnaire rating scale [10]

| Category      | Percentage (%) | Weight |
|---------------|----------------|--------|
| Invalid       | 0-25           | 1      |
| Less Valid    | 26-50          | 2      |
| Valid Enough  | 50-75          | 3      |
| Valid         | 75-100         | 4      |

The formula table 2 explain above to determine the highest validator/answer is:

Determine the percentage of student response assessments:

\[ PPS = \frac{\text{Amount SR}}{\text{Amount ST}} \times 100\% \]

Information:
PPS = percentage of respondents' ratings
SR = total answers by respondents
ST = highest total value by respondents

3. Results and Discussion
The results of this research, a section of the data presentation will be elaborated. Media trainer validation results and job sheet validation results will be presented in the data presented. While the discussion will discuss the process of making a media trainer and compiling a worksheet to the stage of data analysis of research results and explained the workings and programming of input and output programming in 5 experiments and evidence of data collection methods through online. This study produced a product that is an Arduino-based analog and digital application trainer and the existence of a job sheet. Existing components in the trainer are, Push Button, LCD (Liquid Crystal Display) 16 x 2, Ultrasonic Sensor, LM35 Sensor, Potentiometer, LED, Buzzer, DC Motor, and Arduino Uno. Figure 2 is a sample of the results of the trainer's product.

Whereas for the job sheet there are 5 practicum experiments namely programming and arranging the potentiometer input with dc motor output, programming and stringing push-button inputs with LED output (Light Emitting Diode), programming and arranging LM35 temperature sensor input with dc motor output and LCD size 16 x 2, programming and arranging potentiometer input with LED (Light Emitting Diode) output, programming and assembling ultrasonic sensor input with buzzer output and 16x2 size LCD. The results of the assessment of the three validators will be categorized in the
specified assessment criteria. The results of the trainer validation consist of two aspects so that the overall results of the trainer validation are;

![Validation Graph]

**Figure 3.** Graph of the results of validation trainer

Based on Figure 3 that the validation assessment of the trainer received 84.37%. So the analog and digital application trainer based on Arduino Uno has produced a very valid category, it can be used as a supporting tool or media for the competence of applying analog input and output microprocessor programming.

Figure 4, explains about the validation of the job sheet assessed includes 3 aspects, namely illustration, the content of the job sheet, and the appearance of the job sheet.

![Job sheet validation graph]

**Figure 4.** Job sheet validation graph

The overall assessment of the job sheet validation had an assessment result of 81.6%. The appropriate category is used, the Arduino Uno-based analog and digital application worksheet trainer has a value in the Valid category, which can be said that the analog and digital-based Arduino-based application worksheet is categorized as suitable as a learning media on the competence of the application of digital-analog input and output programming.

Questionnaire sheets of student responses or answers that have been made will provide the results of student response data or answers to the analog and digital application trainer based on Arduino Uno. In this research activity, the student response questionnaire instrument in the analog and digital application trainer was answered by UNESA Communication Electronics 2016 students, with 22
students, 7 women, and 15 men. The filling out of the student response questionnaire was carried out by UNESA Communication Electronics 2016 students due to the Pandemic Covid-19 outbreak so the School was closed.

![Student response graph](image)

**Figure 5.** Student response graph

Figure 5 explains the average value of the results of student responses to the Arduino Uno-based analog and digital application trainer with 2 aspects namely the ease of the trainer and aspects of the appearance and quality of the media obtained calculation results of 88.49%.

4. Conclusion

The overall results of students in responding to this trainer as a companion in learning were very good, 88.49%. So it can be concluded that an appropriate media can assist students in learning without the teacher, while based on validation and response states this media is valid and suitable to be used as a companion media in learning microprocessor programming. This trainer is recommended to be a learning medium for students with an explanation from the teacher to understand analog and digital material.

References

[1] N. L. Serdenciuc, “Competency-based Education – Implications on Teachers’ Training,” Procedia - Soc. Behav. Sci., vol. 76, pp. 754–758, 2013, doi: 10.1016/j.sbspro.2013.04.200.

[2] A. Amirkhanova, E. Davletkaliyeva, B. Muldasheva, N. Kibataeva, G. Satygliyeva, and E. Arynhanova, “A Model of Self-education Skills in High Education System,” Procedia - Soc. Behav. Sci., vol. 171, pp. 782–789, 2015, doi: 10.1016/j.sbspro.2015.01.192.

[3] S. Masino and M. Niño-Zarazúa, “What works to improve the quality of student learning in developing countries?,” Int. J. Educ. Dev., vol. 48, pp. 53–65, 2016, doi: 10.1016/j.ijedudev.2015.11.012.

[4] A. A. Genlott and Å. Grönlund, “Improving literacy skills through learning reading by writing: The iWTR method presented and tested,” Comput. Educ., vol. 67, pp. 98–104, 2013, doi:
10.1016/j.compedu.2013.03.007.

[5] V. Z. Mashhadi and M. R. Kargozari, “Influences of digital classrooms on education,” *Procedia Comput. Sci.*, vol. 3, pp. 1178–1183, 2011, doi: 10.1016/j.procs.2010.12.190.

[6] R. Vebrianto and K. Osman, “The effect of multiple media instruction in improving students’ science process skill and achievement,” *Procedia - Soc. Behav. Sci.*, vol. 15, pp. 346–350, 2011, doi: 10.1016/j.sbspro.2011.03.099.

[7] L. Louis, “Working Principle of Arduino and Using it as a Tool for Study and Research,” *Int. J. Control. Autom. Commun. Syst.*, vol. 1, no. 2, pp. 21–29, 2016, doi: 10.5121/ijcacs.2016.1203.

[8] P. Bisták, “Arduino Support for Personalized Learning of Control Theory Basics,” *IFAC-PapersOnLine*, vol. 52, no. 27, pp. 217–221, 2019, doi: 10.1016/j.ifacol.2019.12.759.

[9] S. C. Wibawa, R. Cholifah, A. W. Utami, and A. I. Nurhidayat, “Creative Digital Worksheet Base on Mobile Learning,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 288, no. 1, 2018, doi: 10.1088/1757-899X/288/1/012130.

[10] S. C. Wibawa *et al.*, “Online test application development using framework CodeIgniter,” *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 296, no. 1, 2018, doi: 10.1088/1757-899X/296/1/012041.