**Development Industrial Control Learning Model Based on Augmented Reality at The Polytechnic**

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**Abstract.** This study aims to produce an industrial control learning model based on augmented reality in polytechnics to improve students digital literacy skills in the field of industrial control. The model developed consists of 5 stages, namely: Management, Organization, Digital Literacy, Investigation, and Study Discussion. A wide scale trial design was carried out using a pretest-posttest control group design. The large scale trials were carried out at the Ujung Pandang State Polytechnic and the Bosowa Polytechnic. The analysis of the results of this development includes the validity and effectiveness of the model being developed. The results showed; (1) The industrial control learning model based on augmented reality at the polytechnic is declared valid according to the experts with an average score of 3.6; (2) The model developed is effective to improve students' digital literacy skills in the field of industrial control, while the n-gain in industrial control knowledge is 0.42 in the medium category. Based on the results research, it can be concluded that the industrial control learning model based on augmented reality at the polytechnic being developed is feasible to be used to improve digital literacy skills in the field of industrial control.

**1. Introduction**

Digital transformation has brought about massive changes due to the process of digitizing electronic systems. Today, digital transformation has penetrated various sectors, including in the public service sector such as telecommunications, banking, tourism, health, transportation, production, to the world of education and services. Digital transformation is the main trigger for the movement of the Industrial Revolution 4.0 where massive changes have occurred in design strategies, production processes, automation, order acceptance, to product marketing and delivery caused by digital technology [1].

The development of digital technology cannot be stopped and will continue to grow. Digital technology arrangements are able to have a good or bad impact depending on their designation and management method. In order to be able to compete and win today's global competition, the world of education, especially vocational education, must certainly produce more competitive human resources that are in line with needs. In the era of the Industrial Revolution 4.0, there were three new types of literacy, including data literacy, digital literacy, and humanitarian literacy [2].

The existence of Digital Transformation will certainly bring new opportunities in vocational learning innovation [3]. Digitalization in education can be seen through the concept of digital learning, online courses, e-books, and integrated academic information systems. In education higher, digital learning is a form of disruption in education that has the ability to fundamentally change the learning process. Therefore, in order for graduates to be more competitive, the curriculum in vocational education needs a new orientation that leads to digital learning.

Digital competence is built so that human resources, especially teachers and students, can master digital technology. This is done in order to improve the quality and quality of education. In 21st century learning, educators are required to be able to create digital learning content such as learning application programs, interactive presentations, learning animations, and others [4]. Internalizing the context of digitization, digital transformation, and the industrial revolution 4.0 in learning can be done in the learning design. Learning design with this context can be implemented into a learning model. Because the learning model leads to a particular approach and specific learning so that the digital-based learning approach as stated at the beginning of the discussion can also be internalized into a learning model [5].

One of the digital technologies that can be used in learning is Augmented Reality (AR) technology. This technology will provide an interesting learning atmosphere because it provides a more interactive, 3D, and real display. In addition, Augmented Reality (AR) technology has been developed in making multimedia learning presentations as a teaching aid in the learning process in the classroom, and does not replace the whole teacher [6].



**Figure 1**. Augmented Reality on the e-book [7].

**2. Research Method**

This research is Research and Development (R&D), where the subjects of this study are students of Politeknik Negeri Ujung Pandang and Politeknik Bosowa. The topic taught is Industrial Control Techniques . The final product of this research is industrial control learning model based on augmented reality which valid and effective criteria. The stages of developing this model include the following steps.

2.1 Pre-Development

Stage This stage is carried out by collecting learning information data using descriptive analysis, observation, and documentation of lecture results at polytechnics. The aspects observed include lecture implementation, student characteristics, and the required learning model.

2.2 Development

Stages This stage is carried out by compiling a learning model design and developing learning tools. The goal in compiling the design of the learning model includes aspects, namely learning objectives and learning outcomes of industrial control techniques. Furthermore, the design of this learning model was consulted and validated by a team of experts.

2.3 Trial Stage

This stage includes testing and dissemination activities with the aim of assessing the extent to which the learning model that has been developed meets the valid and effective criteria. Model testing was carried out by involving 30 subjects from the Politeknik Negeri ujung Pandang students as the experimental class and the Politeknik Bosowa as the control class to obtain an overview of the effectiveness of the learning model.

2.4 Implementation Stage

The final results of the model trials are then used as feedback to revise and evaluate the final product. Furthermore, the results of the revised model trial will be disseminated using the pretest-posttest control group design technique which aims to determine the effectiveness of using the learning model so that it is ready for adoption by users.

**Table 1**. Two Group Pretest Posttest Control Design

|  |  |  |  |
| --- | --- | --- | --- |
| Group | Pretest | Treatment | Posttest |
| Exsperiment | O1 | X | O2 |
| Control | O**3** |  | O4 |

Information:

O1 : Pretest of PNUP

O2 : Posttest of PNUP

O3 : Pretest of Politeknik Bosowa Group

O4 : Posttest of Bosowa Polytechnic Group

X : Treatment using industrial control learning model based on *augmented reality*

**3. Result and Discussion**

3.1 Validation Results of Industrial Control Learning Model Based on Augmented Reality

**Table 2.** Recapitulation of Validity Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| No. | Komponen | Validation Score | | | Average | Category |
| V1 | V2 | V3 |
| 1 | Control Industry AR Model | 3,15 | 3,18 | 3,25 | 3,19 | Valid |
| 2 | Learning Plan | 3,51 | 3,43 | 3,45 | 3,46 | Very Valid |
| 3 | Manual Book | 3,00 | 3,23 | 3,25 | 3,16 | Valid |
| 4 | Application AR | 3,35 | 3,43 | 3,54 | 3,44 | Very Valid |
| 5 | The Assesment Sheet | 3,34 | 3,43 | 3,32 | 3,36 | Very Valid |
| Average Validator Rating | | | | | 3,32 | Very Valid |

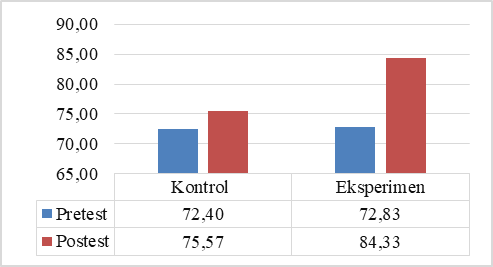
Based on the results of the evaluation of the three validators on the industrial control augmented reality model component, it was obtained an average of 3.19 with the valid category. The learning plan component obtained a value of 3.46 in the very valid category. The manual book component obtained an average value of 3.16 with the valid category. The component application augmented reality obtained an average value of 3.44 with the very valid category. While the assesment sheet component obtained an average value of 3.36 with the very valid category. So that the overall average for the assessment of the validation of the learning model obtained a value of 3.32 in the very valid category.

3.2 The Effectiveness Results of the Industrial Control Learning Model Based on Augmented Reality

**Table 3**. Pretest and Posttest Results Control Class and Experiment Class

|  |  |  |  |
| --- | --- | --- | --- |
| Group | Mean Pretest | Mean Posttest | N-Gain |
| Eksperimen | 72,83 | 84,43 | 0,42 |
| Control | 72,40 | 75,57 | 0,12 |

Based on Table 3 above, the experimental group obtained a mean pretest score of 72.83 and posttest 84.43 with an increase of 0.42 or in the moderate category. Whereas in the control group the mean pretest score was 72.40 and posttest 75.57 with an increase of 0.12 or the low category.

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**Figure 2**. Comparison of learning outcomes of the control class and the experimental class.

The data analysis requirements test was carried out by testing the normality and homogeneity testing. Initial data analysis was carried out after being given a test on the two sample groups so that the initial data and final data were obtained which were then analyzed the data. The normality test was conducted to determine whether the two samples used in this study were normally distributed or not.

**Table 4**. Data Normality Test

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | N | Lo | Lt | Conclusion |
| Experiment | 30 | 0,091 | 0,161 | Normal |
| Control | 30 | 0,126 | 0,161 | Normal |

Based on table 4 in the experimental group, it can be seen that the value of L0 = 0.091 and L table = 0.161 so that LL0 <table so H0 is accepted, meaning that the variable knowledge of industrial control is distributed normal. Whereas in the control group, it can be seen that L0= 0.126 and L table = 0.161 so that LL0 <table so H0 is accepted, meaning that the industrial control knowledge variable is normally distributed. Then the homogeneity test of the industrial control knowledge pretest results is carried out as follows.

**Table 5**. Homogeneity Test of Data

|  |  |  |  |
| --- | --- | --- | --- |
| Levene Statistic | df1 | df2 | Sig. |
| 1.189 | 4 | 23 | 0.342 |

From the test results obtained a significance value (Sig.) Of 0.342> 0.05, so it can be concluded that the variance of the test score for the experimental class and the control class is homogeneous or the same.

**4. Conclusion**

Based on the results and discussion of the study, it can be concluded that: (1) the industrial control learning model based on augmented reality at the polytechnic based on the validators assessment obtained an average of 3.32 with a very valid category. Thus the learning model that has been developed can be applied in polytechnics; (2) the industrial control learning model is effectively used to increase knowledge of industrial control techniques. The n-gain result of industrial control engineering knowledge in the experimental class shows a value of 0.42 in the medium category. Augmented Reality (AR) technology has a system advantage if it implemented appropriately into learning [8]. Besides being applicable to learning, AR can also be applied to entertainment, military, medicine, engineering and manufacturing [9].

Some suggestions from this research are (1) the learning model that has been developed can be carried out further studies on other similar learning; (2) testing is only carried out at two polytechnics so that it is hoped that other researchers will be tested on a wider sample; (3) it is necessary to carry out further studies so that the learning model that has been developed further increases the knowledge of industrial control techniques.

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