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Improved learning outcomes of CNC programming through Augmented Reality job sheet learning media

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Abstract

This study aims to determine: (1) the differences in learning outcomes of students who are taught using Augmented Reality (AR) jobsheet learning media with students taught using conventional learning media, (2) differences in learning outcomes of highly motivated students and low motivated students, and (3) the interaction between Project Based Learning learning methods and learning motivation in influencing learning outcomes. This research is a quasi-experimental research with a population of 64 people, the sample was taken as many as 32 people using the cluster random sampling method. Data were collected using a questionnaire for learning motivation and tests for learning outcomes. The data analysis technique used is descriptive analysis and two-way analysis of variance (Two Ways Anova). The research results found: 1) there are differences in student learning outcomes taught by the Project Based Learning learning method compared to student learning outcomes taught conventionally with F_{count} of 7.98 (2) there are differences in learning outcomes of highly motivated students with low motivated students with F_{count} 34.40, and (3) there is no learning interaction between learning methods and learning motivation in influencing student learning outcomes with F_{count} 3.19

Keywords: Jobsheeet, Augmented Reality, Learning Outcomes, Motivation

1. Introduction

Technology has developed significantly towards Indonesia being superior, advanced and competing with developed countries in the world. As the current generation of undergraduates grow up, information and communication technology (ICT) has become an indispensable part of life. [1].Students as agents of change are required to compete in the era of the industrial revolution 4.0. These driving forces have made the Fourth Industrial Revolution one of the most discussed topics in many manufacturing conferences, forums and exhibitions in recent years. [2]. The industrial revolution 4.0 starts with the internet revolution which began in the 90s [3]. Education is a forum for developing the potential of students [4]. However, education has decreased in various aspects due to COVID-19. COVID-19 has forced governments to immediately launch or scale up distance learning programs, and it seems that the ideal prerequisites for such a rapid rollout do not exist worldwide. [5]. World education faces many challenges, one of which is the learning process turning into online, the online learning system makes it difficult for students to understand the learning process. Different studies consistently find that digital technology is associated with moderate learning gains [5]. Learning outcomes are an important indicator in seeing improvements in the quality of education. Many factors influence student learning outcomes, from student involvement in lectures to approaching these courses. Enthusiasm and motivation tend to influence how students are produced.

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Science and technology have an impact on the current learning process, especially in vocational higher education. The use of information technology is sometimes not realized among students, because the lack of knowledge and knowledge makes them lazy and difficult to understand learning. *Augmented Reality* (AR) technology is present as a medium that connects the virtual world with the real world. *Augmented reality* (AR) is a key technology for enabling Industry 4.0 concepts [6]. This technology enables the enhancement of our senses (aural, tactile, and vision) with virtual or invisible information naturally superimposed over the real world in a digital way. [7]. Augmented reality, like 3D digital virtual worlds, offers different levels of immersion and interaction that might help engage students in learning activities.[8]. Vocational higher education produces competent graduates who have met the qualifications and are ready to enter the world of work. The success or failure of the role of vocational education can be measured from the balance of these two goals, namely the development of the whole human being and the development of the whole Indonesian society [9]. More practical courses are implemented than theoretical courses. In courses, it is often facilitated with learning media in the form of worksheets as a procedural guide for doing a practice. This has been applied to vocational schools, especially DIII majoring in Mechanical Engineering, Faculty of Engineering, Padang State University (Mechanical Engineering FT-UNP) [10]. Jobsheets are learning tools that must be prepared by lecturers before carrying out practical lectures.

Observations that have been made in the field show that there are still many students who do not understand how to read work drawings and symbols contained in jobsheets in the Computer Numberical Control (CNC) course, because these difficulties make it difficult for students to interpret 2D images into 3D, which is due to a lack of information. contained in the jobsheet for CNC programming courses. Jobsheets have often been used as a reference in practice, but the lack of information still makes it difficult for students to understand them. This is where Augmented Reality Technology acts as a medium in facilitating learning. If the learning process is considered, AR devices are learning media that allow the creation of a new learning climate because of the use of digital engineering technology in helping students learn independently. [11].

2.1 Jobsheet

Jobsheet are printed work sheets aimed at making students learn independently with or without educators [12]. Jobsheet is a sheet of paper that contains practical work procedures that include practical goals, as well as assignments before and after practicum with the aim that students understand and are able to learn independently. Requirements for a good jobsheet are a jobsheet containing at least 1) work instructions 2) competency in achievement, 3) introduction to practice, 4) additional information. A jobsheet will be meaningful if students can easily understand and use it [13]. In preparing a jobsheet, the following steps can be taken: (1) Curriculum analysis, (2) Jobsheet Needs Map (3) Determine Jobsheet Title (4) Jobsheet Writing.

2.2 Augmented Reality

Augmented reality (AR) technology is a vision technology that combines virtual objects or worlds into real-time real-time views. [14]. AR is an excellent technology that can perform human-computer interaction and hologram/information display in the context of the real world [15]. Initially, the researchers defined AR based on dedicated facility equipment, such as head-mounted displays (HMD).[16].

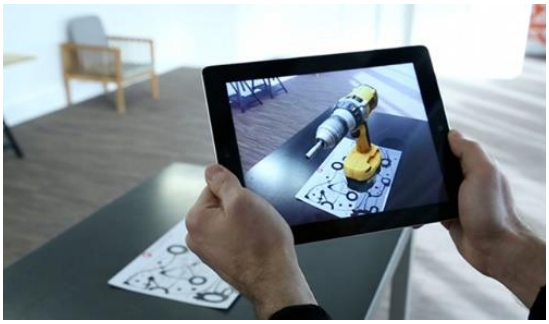

Figure 1. Overlay of Augmented Reality Graphics

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A specific design principle of the AR learning environment is real-time feedback on experimental actions, which provides evidence for a better understanding of the theory-experiment relationship. [17]. Augmented reality displays computer-generated content serving as a backdrop in aggregated real-world data Figure 2 illustrates the spectrum of mixed reality (MR), or the Continuum of Reality-Virtue (RV).

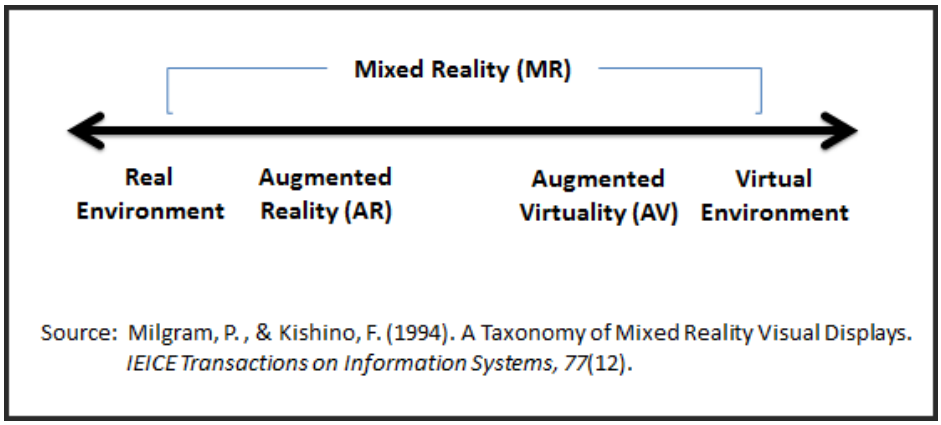
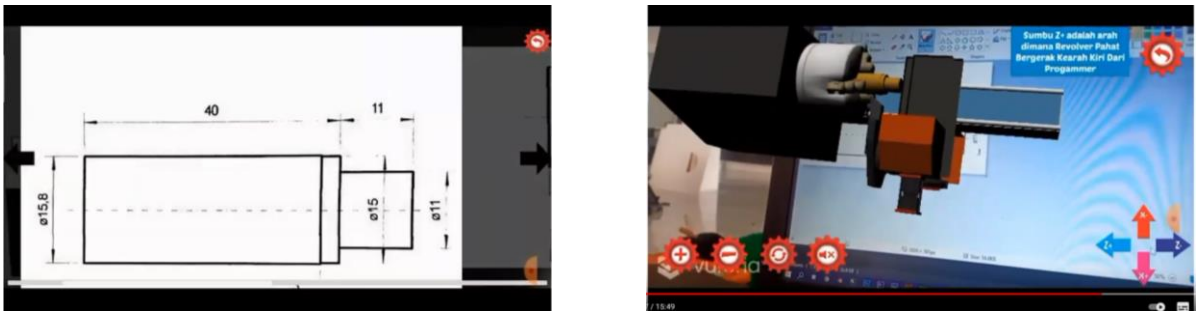


Figure 2. Reality-Virtuality (VR) Continuum

AR is near to the real world at one end with the dominant perception being the real world enhanced by digital data or assets. As technology continues to develop rapidly, it seems that the virtual elements and the real world elements that divide the space in a reality environment will become increasingly difficult to separate. The components of augmented reality are: (1) The scene generator is the hardware or software responsible for creating scenes. (2) The tracking system is one of the most important problems in the AR system, mainly due to the registration problem [16]. The objects in the real world and the virtual world must be aligned correctly, otherwise the illusion of coexistence of the two worlds will be damaged. For industry, many applications require accurate registration [18]. (3) Display and AR technologies are still under development, and the solution depends on design decisions. Display technology is still a limiting factor in the development of AR systems. There is still no transparent screen with enough resolution, field of view, brightness and contrast to seamlessly mix real and virtual images [19]. The design of the CNC jobsheet uses a printed jobsheet marker then when the marker is marked it will display a 3D object from the object and will show the animation of the process of working on the object with a CNC machine., such as Figure 3. In the CNC AR jobsheet application the user is also possible to access the e-module cnc programming lesson Figure 4. The module contains most of the material related to CNC machines both CNC Training Unit 2 Axis and 3 Axis



(a) (b)

Figure 3. Visualization of Augmented Reality
(a) Marker, (b) 3D Object

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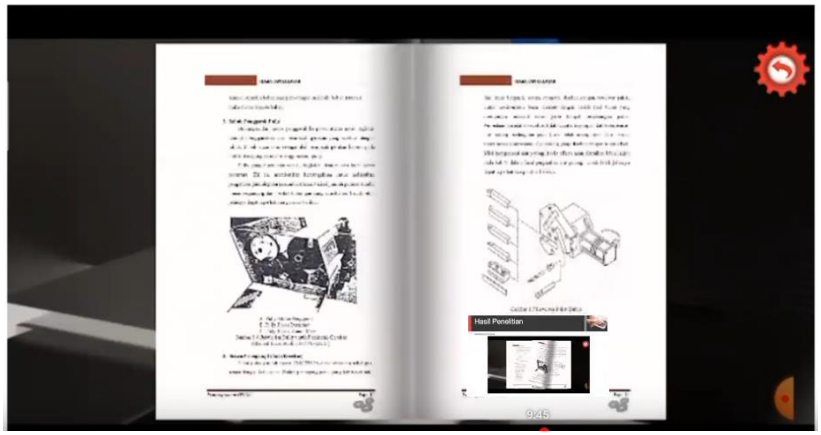

Figure 4. E-Module in Jobsheet CNC AR

2.3 Learning Motivation

Motivation and learning are two things that influence each other. [20] argue that the factors that influence learning motivation are intrinsic motivation, self-efficacy, self-determination, value motivation, and career motivation. Meanwhile, Keller [21] argues that the characteristics of people who have motivation must be seen Attention, Relevance, Convidence, Satisfaction or abbreviated as ARCS in learning. Some characteristics of educators in an effort to provide motivation to students:

1) Educators Can appreciate the opinions, thoughts, feelings, and beliefs of students.
2) Educators use various methods in carrying out their educational activities.
3) Provide guidance and also direction to students in overcoming their difficulties.
4) Educators must have extensive knowledge.
5) Educators must have a sense of love and devotion to their profession as educators.

2. Method

Based on the problems and objectives to be achieved, this type of research is quasi-experimental research. By comparing high motivation students in the experimental class with high motivation students in the control class and low motivation students in the experimental class with low motivation students in the control class. The determination of high and low student motivation is seen using a questionnaire with the following indicators: (1). Attention in the learning process, (2) Seriousness in learning, (3) Confidence, (4) Satisfaction, (5) Awareness of the benefits of learning. If the total value is greater than the average value, it is considered that students have high learning motivation

Table 1. Research Design

Learning Media (A) / Motivasi to Learn (B)	AR Job sheet (A1)	Regular Job sheet (A2)
High (B1)	A1B1	A2B1
Low (B2)	A1B2	A2B2

Information:
A1B1: Groups students with job sheet AR who have high learning motivation.
A2B1: Groups students with regular job sheets who have high learning motivation.
A1B2: Groups students with AR job sheets who have low learning motivation.
A2B2: Group of students with regular job sheets who have low learning motivation.

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The sampling technique of the study was carried out using a cluster random sampling model in 2 classes of CNC programming courses and obtained 1 experimental class and 1 control class with a total of 16 students in each class. limited to workshops and efforts to optimize the use of machines, tools and facilities by each student when practicing in each section

Research Instruments

Questionnaire Instruments

The preparation of this research questionnaire is based on existing indicators in previous theories that have been described in the literature review section. The indicators for student learning motivation are: (1) Attention in learning, (2) Seriousness in learning, (3) Self-confidence, (4) Satisfaction, (5) awareness of the benefits of learning. The questionnaire was based on a thesis whose [22] To find out the validity of instrument is done using the product moment correlation formula. Items of the instrument are said to be valid if r count > r table or Sig < alpha 0.05. There are 32 valid questions that are used to see student motivation. While the reliability value of the instrument used from 32 questions is 0.943.

Data Analysis Techniques

Descriptive Analysis

The data analysis technique used to research and classify students based on their learning motivation towards CNC programming courses in this study is descriptive statistical techniques, namely by calculating the frequency of each alternative answer given by the respondent, as expressed as follows:

$$X = \frac{\sum X_i}{n}$$

Information: X = average value

N = Number of research subjects

$\sum X_i$ = Total value of respondents' answers based on the Likert scale

Test Requirements Analysis

Normality Test

The preliminary analysis of experimental research data includes two stages, namely normality test and homogeneity test. The normality test is intended as the first step in statistical data processing, especially to determine the use of parametric or nonparametric statistics. The normality test is to determine whether the data is normally distributed. The normality test used is the Kolmgorov Smirnov one-sample test.

Class is declared to be normally distributed if If Sig. (p) ≥ 0.05 means that the data is normally distributed with an error rate of 5%. The normality test is obtained with the help of the SPSS 17 program [23].

Homogeneity Test of Variance

The homogeneity test is carried out to obtain the assumption that the research sample departs from the same or homogeneous conditions. The statistical analysis used was the homogeneity of variance test with the help of the SPSS 17 program. The criteria used to determine the homogeneity of the variants were [23]:

If Sig. (p) ≥ 0.05 means the data is homogeneous (uniform)

If Sig. (p) <0.05 means that the data is not homogeneous (not uniform)

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Hypothesis Testing

Testing the hypothesis collectively, namely the effect of AR job sheet learning and learning motivation on CNC programming courses at level 2 students of mechanical engineering FT UNP carried out Two Ways Anova analysis is an analytical technique used to test more than two or more samples with two the factors to determine the significant difference (clear) between the calculated means of several data groups. The research hypothesis is : (1) There is no difference in student learning outcomes in CNC programming courses taught using project based learning methods with student learning outcomes taught using conventional learning methods. (2) There is no difference in the learning outcomes of students who are highly motivated in CNC programming courses with students who are low motivated at level II students of the Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang.

3. Results and Discussion

3.1 Learning Outcomes of CNC Programming

Based on the data processing of the learning outcomes of the subjects of CNC programming using *Augmented Reality* based job sheet learning media and job sheet learning media,

Table 2. Results of Learning Outcomes Data Analysis

Statistics	Experiment Class		Conventional	
	Pre test	Post test	Pre test	Post test
1. Highest score	76.7	86.7	70.0	86.7
2. Lowest Score	33.3	53.3	36.7	33.3
3. Mean	60	73.1	59.3	62.1
4. St. Deviation	13.2	17.38	8.9	10.28
5. Number of Students	16	16	16	16

If seen from Table 2. the learning outcomes of the experimental group obtained a higher value of learning outcomes in the conventional group, this can be seen from the mean of the two-class groups where the experimental class (AR job sheet learning media) obtained a mean value of 73.1 while for class control mean score 62.1 from 8 students for each class.

3.1.1 Distribution of Student Learning Outcomes in Experiment Class

The data frequency distribution and the histogram of the experimental class student learning outcomes can be seen in Table 3.

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Table 3. Frequency distribution of Experiment Class CNC Programming Learning Outcomes

Interval	Frequency (fo)	Percentage (%)	Cumulative Frequency (fk)	Cumulative Frequency (%)
53-59	2	12.5	2	12.5
60-66	2	12.5	4	25
67-73	1	6.25	5	31.25
74-80	9	56.25	14	87.5
81-87	2	12.5	16	100
Total	32	100		

The learning outcomes data of the experimental class students' CNC programming courses were obtained after the use of AR job sheet learning media was applied. Based on the data on student learning outcomes in the experimental class, the highest score was 87 and the lowest score was 53, with the value that had the most frequency in the 74-80 interval totaling 9 people. Overall learning outcomes from the experimental class with AR job sheet learning media obtained better scores than learning outcomes in conventional learning methods with lecture methods and blackboard media. This can be seen from the results of the highest score, lowest score, average value, which have been obtained for both classes. For more details, see Figure 5. below.

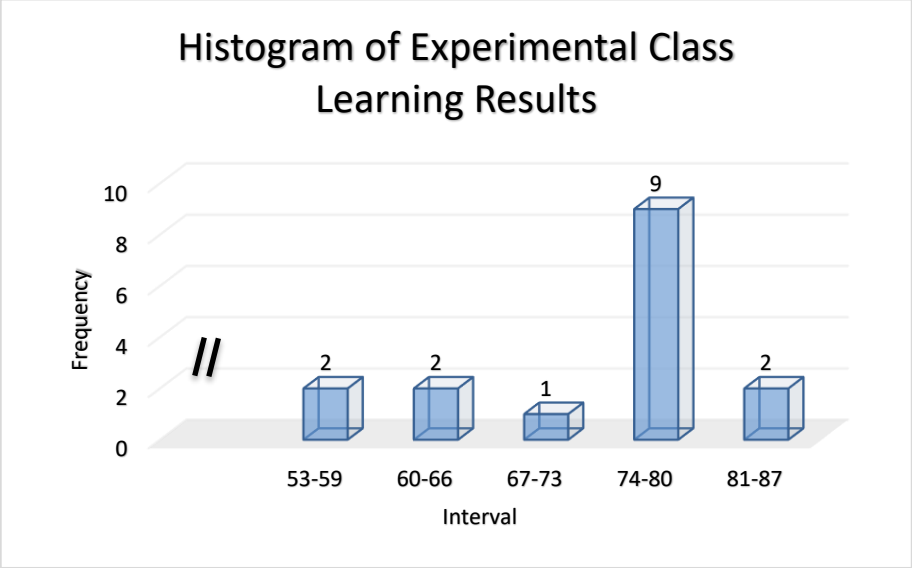

Figure 5. Histogram of Frequency of Experimental Class Learning Outcomes

3.1.2 Distribution of Control Class Student Learning Outcomes

The learning outcomes data of control class students' CNC programming course were obtained after conventional learning was applied. Based on the data on student learning outcomes in the control class, the highest score of students was 86.7 and the lowest score was 33.3, with the highest frequency at 55-65, namely 6 students.

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Table 4. Frequency distribution of Control Class Learning Outcomes

Interval	Frequency (fo)	Frequency (%)	Cumulative Frequency (fk)	Cumulative Frequency (%)
33 - 43	3	18.75	3	18.75
44 - 54	0	0	3	18.75
55 - 65	6	37.5	9	56.25
66 - 76	4	31.25	13	81.25
77 - 87	3	18.25	16	100
Total	16	100		

Based on Table 4. above, it can be seen that students who scored above 66 were 7 students while students who got scores above 66 were 9 students. For more details, see Figure 6.

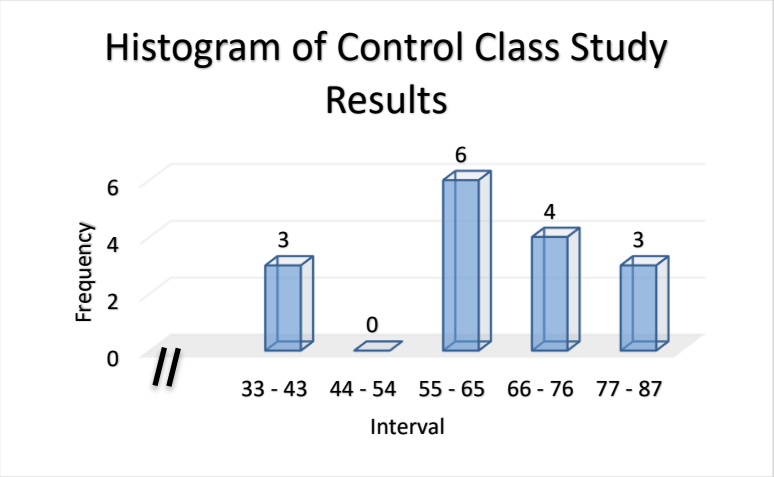

Figure 6. Histogram of Frequency of Control Class Learning Outcomes

3.2 Testing Requirements Analysis

Data analysis was performed to test the accuracy of the hypothesis proposed in the research, that is, the implementation of AR-Job sheet CNC learning media has a significant impact on the learning outcomes of DIII level II students in the DIII mechanical engineering profession. To understand whether this hypothesis is accepted or rejected, the author compares the learning outcomes of the students in the experimental class with the learning outcomes of the students in the control class.

3.2.1 Normality Test of Learning Outcomes

Based on the Kolmogorov test, the test data for learning outcomes of CNC programming courses in classes that are taught using AR-Job sheet CNC learning media and learning media in the form of providing teaching materials through documents are tested for normality at a large level of 0.05. It is obtained that students who are taught using AR and conventional job sheet learning media are normally distributed because the significance value or probability value is> 0.05, it can be concluded that the student learning outcomes are normally distributed. Data can be seen in Table 5.

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Table 5. Learning Outcomes Normality Test

	Factor	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistics	df	Sig.	Statistics	Df	Sig.
Learning outcomes	Experiment Class	.173	16	.200 *	.920	16	.171
	Control Class	.146	16	.200 *	.927	16	.220

a. Lilliefors Significance Correction

The results of the normality test from Table 5 above show the significant value in the Kolmogrov-Smirnov column, for the experimental class taught using *Augmented Reality* based Job sheet learning media and the control class taught using ordinary job sheet learning media in the form of a pdf file of 0.200 which means> than 0, 05. This shows that the data used in this study are normally distributed and can be used for further tests.

3.2.2 Normality Test of Learning Outcomes

After carrying out the normality test, the homogeneity test is carried out attached to attachment 28 on page 196. The homogeneity test aims to determine whether the two groups of data have homogeneous variances or not. The results of the homogeneity test from the research data were obtained with the help of SSS version 17 with the following results. Based on Table 4.10, it can be seen that the significance value of learning outcomes in the line based on mean is 0.114 which means> 0.05, it can be decided that the student learning outcomes data obtained in this study have the same variance. As for motivation, the calculation results are obtained in Table 4.11.

3.3 Hypothesis Testing

After carrying out the normality test and the homogeneity test of variance The hypothesis was developed based on a research design using a 2 × 2 factorial design. This design shows that there are two factors that are involved. Consider student learning outcomes, namely the learning media factor and student learning motivation. Student learning outcomes are obtained from the post test given at the end of the lecture which can be seen in appendix 26 page 199 for the experimental class and attachment 27 pages 200 for the control class the average value of the two classes is depicted in Table 6.

Tabel 6. Post Test Data for The Experimental Class and The Control Class

No.	Data	Experimental Class Learning Outcomes	Control Class Learning Outcomes
1.	Mean	73,1	63,5
2.	S2	302,06	105,67
3.	S	17,38	10,28

From Table 6. it can be seen that the average value (mean) for the class experiment is 73.1, and the mean value (mean) of the control class is 63.5. This proves that the average value of the experimental class is higher than the average value of the control class. As for the standard deviation, the experimental class was 17.38, and the control class was 10.28 so that these two classes were normally distributed. Students are grouped into two categories, namely students who have high learning motivation and low initial learning motivation. The number of students for each category in the experimental class was 16 people while in the control class there were 16 people. The results of the two-way ANOVA test data processing can be seen in appendix 31 on page 208. Thus, the analysis approach used is Two Ways Analysis of Variances as seen in Table 7.

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Tabel 7. Two-Way Analysis of Dependent Variants: Learning Outcomes

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4157.973a	3	1385.991	15.195	.000
Intercept	149508.790	1	149508.790	1639.141	.000
A	728.665	1	728.665	7.989	.009
B	3138.300	1	3138.300	34.407	.000
A * B	291.008	1	291.008	3.190	.085
Error	2553.926	28	91.212		
Total	156220.690	32			
Corrected Total	6711.900	31			

A = Learning Media
B = Learning Motivation

3.3.1 First Hypothesis Test

The hypothesis states that there are differences in the learning outcomes of student's CNC programming courses taught with learning media *Job Sheet* which is based on *Augmented Reality* is higher than student learning outcomes taught by modules through the elearning2 platform. unp.ac.id. For the CNC programming course, hypothesis testing is carried out by means of a two-way analysis of variance. Based on table 7, it can be seen that F counted at 7.989 significance for the learning method 0.009 with a confidence level of 95% with a significant probability of 0.05. Because 0.009 <0.05 then the null hypothesis (H_0) is rejected, that the learning outcomes of students' CNC programming courses taught with-based *Job Sheet* are *Augmented Reality* different from student learning outcomes taught in modules through the elearning2.unp.ac.id platform.

3.3.2 Second Hypothesis Test

The hypothesis states that there are differences in the learning outcomes of highly motivated students and low motivated students in CNC programming subjects. For the CNC programming course, hypothesis testing was carried out using a two-way analysis of variance, with the following results. Based on table 7, it can be seen that the F value counted 34.407, the significance for learning motivation is 0.000 with a confidence level of 95% with a significant probability of 0.05. Because 0.000 <0.05, the null hypothesis (H_0) is rejected, that the learning outcomes of students who have high motivation in the CNC programming course are different from the learning outcomes of students who have low motivation.

3.3.3 Third Hypothesis Test

The hypothesis states that there is no learning interaction between learning methods and learning motivation in influencing student learning outcomes in CNC programming courses. Based on table 4.13, it can be seen that F counted 3.190 with a probability of 0.085 with a confidence level of 95% with a significant probability of 0.05. Because 0.085> 0.05 null hypothesis (H0) is accepted, there is no learning interaction between learning machines and learning motivation in influencing student learning outcomes in the CNC programming course. For more details, there is no interaction regarding learning media with learning outcomes, see Figure 7. Figure 7. shows that the learning outcomes of students who are taught with *Augmented Reality* based *Job Sheet* are higher than learning media modules through the elearning2.unp.ac.id platform. Likewise, student learning outcomes who have high motivation are more likely to get higher results than students who have low motivation. This description shows that there is no interaction between learning methods and learning motivation. The results of testing the first hypothesis, based on the analysis with Two Ways Analysis of Variances, show that the learning outcomes of students who learn using Job sheet AR learning media are different from the learning outcomes of students taught using learning media using modules at elearning2.unp.ac.id.

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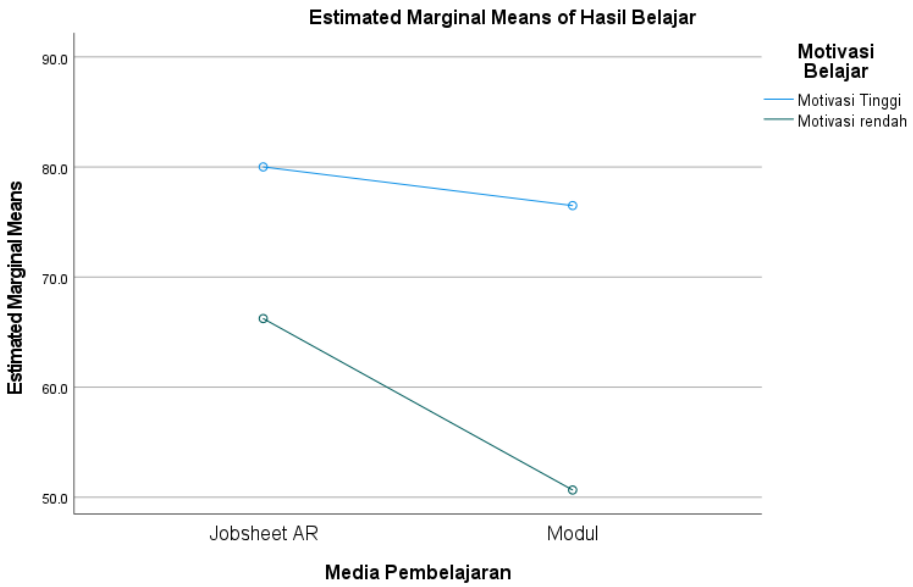

Figure 7. The average value of learning outcomes

Overall, students who take learning using Job sheet AR learning media show higher learning outcomes in CNC programming compared to students learning using conventional learning methods. This can be proven by the difference in the average score of the CNC programming courses for the two classes. For classes learning using the Job sheet AR learning media, the average score is 73.5, while for students taught using conventional learning methods the class average is 63.5, and these two learning methods provide statistically different. Learning outcomes were taught with the AR Job Sheet learning media, is waiting because Job Sheet *Augmented Reality* itself is a technology development that can bring virtual objects into the real world in 3D, AR is specifically designed to help facilitate student practicum learning in CNC programming courses. *Augmented Reality* itself is a technology development that can bring virtual objects into the real world in 3D, AR technology itself has been developed as an assistive medium in the fields of medicine, education, art, animation, and others [24].

4. Conclusion

The results of testing the first hypothesis, based on the analysis with Two Ways Analysis of Variances, show that the learning outcomes of students who learn using AR job sheet learning media are different from the learning outcomes of students taught using learning media using modules at elearining2.unp.ac.id. Overall, students who took part in learning using AR job sheet learning media showed higher learning outcomes in CNC programming courses compared to those of students learning with conventional learning methods. This can be proven by the difference in the average score of the CNC programming courses for the two classes. For classes learning with the AR job sheet learning media, the average score is 73.

Student learning outcomes taught with AR job sheet learning media are waiting because AR job sheet media is specially designed to help facilitate student practicum learning in CNC programming courses. *Augmented Reality* itself is a technology development that can bring virtual objects into the real world in 3D, AR technology itself has been developed as an assistive medium in the fields of medicine, education, art, animation, and others.[24]. In the field of Education [25] said that AR technology provides the feasibility of the practicum learning process both in improving the training process and learning time so that learning is more efficient.

References

[1] J. Gutmann, F. Kühbeck, P. O. Berberat, and M. R. Fischer, "Use of Learning Media by Undergraduate Medical Students in Pharmacology : A Prospective Cohort Study," pp. 1–11, 2015, doi: 10.1371/journal.pone.0122624.

[2] Y. Liao, F. Deschamps, E. De Freitas, and R. Loures, "Past , present and future of Industry 4 . 0 - a systematic literature review and research agenda proposal," *Int. J. Prod. Res.*, vol. 7543, no. November, p. 0, 2017, doi: 10.1080/00207543.2017.1308576.

[3] J. Iqra, "Disruptif diri pustakawan dalam menghadapi era revolusi industri 4.0 Endang Fatmawati," vol. 12, no. 01, pp. 1–13, 2018.

[4] S. S. Pratiwi, "Pengaruh Keaktifan Mahasiswa Dalam Organisasi Dan Motivasi Belajar Terhadap Prestasi Belajar Mahasiswa Fakultas Ekonomi Universitas Negeri Yogyakarta," *J. Pendidik. dan Ekon.*, vol. 6, no. 1, pp. 54–64, 2017, [Online]. Available: http://journal.student.uny.ac.id/ojs/index.php/ekonomi/article/view/6074.

[5] K. Geven, "Simulating the Potential Impacts of COVID-19 School Closures on Schooling and Learning Outcomes: A Set of Global Estimates," 2020.

[6] P. Slamet, "Peran pendidikan vokasi dalam pembangunan ekonomi," *Cakrawala Pendidik.*, no. Juni, pp. 189–203, 2011.

[7] R. Widyastuti and I. S. Utami, "Development of Product-Based Job Sheet as Instructional Media in Vocational Education," *J. Educ. Sci. Technol.*, vol. 4, no. 2, pp. 119–125, 2018, doi: 10.26858/est.v4i2.6064.

[8] S. Romina and P. Afonso, "Augmented Reality in Training," *Procedia Manuf.*, vol. 31, pp. 85–90, 2019, doi: 10.1016/j.promfg.2019.03.014.

[9] A. Jakl, L. Schöffer, M. Husinsky, and M. Wagner, "Augmented reality for industry 4.0: Architecture and user experience," *CEUR Workshop Proc.*, vol. 2299, pp. 38–42, 2018.

[10] M. K. Bekele, R. Pierdicca, E. Frontoni, E. S. Malinverni, and J. Gain, "A survey of augmented, virtual, and mixed reality for cultural heritage," *J. Comput. Cult. Herit.*, vol. 11, no. 2, pp. 1–36, 2018, doi: 10.1145/3145534.

[11] Á. Di, M. Blanca, and C. Delgado, "Computers & Education Impact of an augmented reality system on students ' motivation for a visual art course," *Comput. Educ.*, vol. 68, pp. 586–596, 2013, doi: 10.1016/j.compedu.2012.03.002.

[12] F. Nopitasari and W. Purnama, "Penggunaan Jobsheet Interaktif dalam Praktikum Analisis Rangkaian Listrik dan Elektronika," *Innov. Vocat. Technol. Educ.*, vol. 8, no. 2, pp. 137–146, 2017, doi: 10.17509/invotec.v8i2.6127.

[13] M. Ridwan, "Analisis Penggunaan Jobsheet Pada Mata Kuliah Praktek Instalasi Listrik," *J. Tek.*, 2010.

[14] M. Fathoni, E. B. Cahyono, and W. A. Kusuma, "ALAT MUSIK PERKUSI AUGMENTED REALITY BERBASIS ANDROID," 2012.

[15] P. Stief, J. Dantan, A. Etienne, and A. Siadat, "Developing an Augmented Reality Based Training Demonstrator for Developing an Augmented Reality Based Training Demonstrator for Manufacturing," *Procedia CIRP*, vol. 81, pp. 803–808, 2019, doi: 10.1016/j.procir.2019.03.203.

[16] R. Azuma, "Tracking Requirements for Augmented Reality," *Commun. ACM*, 1993, doi: 10.1145/159544.159581.

[17] M. P. Strzys, S. Kapp, M. Thees, P. Klein, and P. Lukowicz, "Physics holo . lab learning experience : Using Smartglasses for Augmented Reality labwork to foster the concepts of heat conduction," pp. 1–14, 2018.

[18] B. Inggris, "Pengembangan Education Game (Edugame) Berbasis Android Pada Mata Pelajaran Bahasa Inggris Untuk Peserta Didik Sekolah Dasar," vol. 2, no. November, pp. 1–9, 2015.

[19] W. R. Sherman and A. B. Craig, *Understanding Virtual Reality: Interface, Application, and Design*. 2003.

[20] J. Filgona, J. Sakiyo, D. M. Gwany, and A. U. Okoronka, "Motivation in Learning," *Asian J. Educ. Soc. Stud.*, pp. 16–37, Sep. 2020, doi: 10.9734/AJESS/2020/V10I430273.

[21] J. B. Huett, K. E. Kalinowski, L. Moller, and K. C. Huett, "Improving the Motivation and Retention of Online Students Through the Use of ARCS-Based E-Mails," *http://dx.doi.org/10.1080/08923640802224451*, vol. 21, no. 1, pp. 159–176, 2008, doi: 10.1080/08923640802224451.

[22] F. Prasetya, "Tinjauan Minat Belajar Siswa SMK Semen Padang pada Mata Pelajaran Teknik Pemesinan di Balai Latihan Pendidikan Teknik (BLPT) Provinsi Sumatera Barat," 2012.

[23] B. W. Yap and C. H. Sim, "Comparisons of various types of normality tests," *J. Stat. Comput. Simul.*, vol. 81, no. 12, pp. 2141–2155, 2011, doi: 10.1080/00949655.2010.520163.

[24] M. Billinghurst and H. Kato, "Collaborative augmented reality," *Commun. ACM*, vol. 45, no. 7, pp. 64–70, 2002, doi: 10.1145/514236.514265.

[25] F. Ferrati, J. A. Erkoyuncu, and S. Court, "Developing an augmented reality based training demonstrator for manufacturing cherry pickers," *Procedia CIRP*, vol. 81, pp. 803–808, 2019, doi: 10.1016/j.procir.2019.03.203.