Augmented Reality Technology Based on Biological Practicum Due to Improving Student's Ability of Digital Literacy

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Abstract. Digital literacy skills are an effort that students in this sophisticated era need to filter information accurately as an educational medium. It is because digital literacy uses appropriate applications through Augmented Reality (AR) technology. The primary purpose of this study is to analyze the application of Augmented Reality (AR) technology to improve the digital literacy skills of high school students in Surabaya. The research method applied in this study was quantitative research conducted on approximately 100 high school students in Surabaya City and senior high schools in three private high schools in Surabaya, Indonesia. The selection of participants by purposive sampling was based on the inclusion criteria. The researcher conducted and data collection was carried out through google form. The data obtained in the study were statistically processed using a Correlational Approach (Correlational research) and Linear Regression. This study was conducted to test hypotheses related to the relationship between the variables of the application of augmented Reality (AR) technology on students' digital literacy abilities. Based on this research, the correlation coefficient with a significant value of $0.000 < 0.05$ emphasizes that Ho is rejected and H1 is accepted. Thus, the conclusion is a relationship between AR applications and students' digital literacy abilities. Furthermore, following the t-test, the significance value of 0.000 is smaller than 0.05. Therefore, using augmented reality (AR) technology through biology practicum can improve the digital literacy skills of high school students.

Keywords: augmented reality technology · biology practicum · digital literacy skill

1 Introduction

Advances in information technology have developed dynamically and have become part of the needs of all human life [1, 2]. On the other hand, the role of technology has a tremendous impact on the world of education that is happening now [3, 4]. The development of today's information technology helps students gain knowledge not only

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by meeting face to face during the learning process but also by accessing the internet to get material they can learn quickly [5, 6]. This technology is a learning platform that can be applied effectively and efficiently. It.

The biology practicum, often done conventionally, gives a monotonous impression on the learning process, impacting student boredom. The fundamental biology practicum learning process should emphasize a constructive learning process [7, 8]. Biology learning is not only theoretical but also more about implementing practicum to combine theory with practicum carried out by students [9]. Biology learning must also adapt to dynamic technological developments [10]. It is because technology allows a change in learning orientation from what was originally only a presentation of knowledge from one party to a guidance process for interactive knowledge exploration involving students [11, 12].

Shifting the paradigm of teacher-centred learning philosophy to student-centred learning is possible with technological advances [13, 14]. Success in the biology practicum learning process is influenced by several factors, including teacher, student, media, and environmental factors. A biological learning process can be done in several ways: development by optimizing learning media [15–17]. The media used to facilitate communication in the learning process is an effort to foster teacher creativity in utilizing technology to improve the quality of learning [18, 19]. Finally, the technology in question has an orientation in the learning process, namely Augmented Reality technology [20].

Augmented Reality (AR) is one of the technologies in the multimedia field that can combine digital objects with the natural world; in other words, it is a combination of the digital world and the real world, which in its application uses camera media [21, 22]. AR provides users with an overview of the merging of the natural world with the virtual world seen from the same place [23]. AR has three characteristics: interactive in real time and 3-dimensional (3D) form [24, 25]. AR technology has become an important field of research, especially in Indonesia. The potential of AR in Indonesia is proliferating even though it is not as massive as abroad [26]. By definition, AR is a combination of objects in the virtual world that are applied to the real world in two-dimensional or three-dimensional forms so that they can be touched, seen, and heard [27, 28].

AR technology has great potential in biology because it displays attractive visuals as well as 3D and animation and emphasizes more practical learning [29, 30]. Using AR technology in biology learning, students can easily visualize biology practicum objects in 3 dimensions [9, 29–31]. AR has the advantage of being interactive and real-time, so AR provides convenience in the learning process, which has a comprehensive implementation in various fields, especially in biology learning [6, 32]. Biology learning related to Augmented Reality (AR) technology can be used directly on the user as learning so that the user can study the organs of the human body and so on according to the simulated object [5, 9, 10].

Augmented Reality technology makes it easy for students to learn to do biology practice and helps them learn biology for fun [11, 12]. The technology's design impacts students' digital literacy skills in a better direction. Then the biology practicum learning process is said to be good if it contains interactive, fun, challenging, and motivating aspects and provides more space for students to develop their digital literacy skills [14].

Although the teacher is only a facilitator in the learning process, and students are required to be more active, the teacher must be able to create a pleasant learning atmosphere to stimulate students to be more involved in learning [15, 16]. Fun learning activities are strongly influenced by various factors, one of which is the selection of learning media that used to be more attractive, interactive, and fun [17].

Advances in Augmented Reality technology used in the form of learning media can make it easier for students to improve students digital literacy skills [18, 19]. Digitalization is inevitable, which can give birth to the importance of digital literacy, including in the learning process [33, 34]. Technology development is a new challenge in designing teaching models, implemented into the biology practicum learning process: Augmented Reality (AR) technology [35, 36]. Because using learning media using Augmented Reality makes it easy for students to learn and is fun, it can provide convenience in improving students' digital literacy [37]. Then digital literacy is the ability of a child to understand and use information from various digital sources [38, 39].

Digital literacy is an individual's interest in attitudes and abilities in using digital technology and communication tools to access, manage, analyze, and evaluate information, build new knowledge, and communicate with others to participate effectively [21, 40]. Digital literacy is an individual's interest in attitudes and abilities in using digital technology and communication tools to access, manage, analyze, and evaluate information, build new knowledge, and communicate with others to participate effectively [41, 42]. Five other things include literacy, numeracy, science, finance, culture, and citizenship [24]. Digital literacy can apply in families, schools, and communities. Digital literacy can be grown with electronic-based learning called Augmented Reality (AR) technology media [23, 25]. Digital literacy not only refers to operating skills and using various information and communication technology devices but also to the process of reading and understanding the content of technological devices and the process of creating and writing new knowledge [26, 27, 43].

2 Research Method

A. Design

This research is a quasi-experimental type of research. The research subjects in this study were students of SMA Muhammadiyah Surabaya City by giving treatment in the form of augmented reality technology based on biology practicum to improve students' digital literacy skills. Therefore, the independent variable in this research is Augmented Reality (AR) technology based on biology practicum. At the same time, the dependent variable listed in this study is the students' digital literacy ability.

B. Participants

In determining the respondents in this study, the Muhammadiyah high school in Surabaya was first selected as the research setting. Then, researchers determined the research sites in two schools in Surabaya, East Java, Indonesia. The study site was carefully chosen because of comments about the difficulty of mastering biology labs conducted with the limited tools and materials for biology labs in schools. Combine this targeted technique with the snowball technique to select respondents. The criteria for respondents in this study were students of SMA Muhammadiyah 1 Surabaya and SMA Muhammadiyah 10 Surabaya. The study subjects used were 95 students who participated discreetly in this study. Their average age is 17–18 and they are in grades 10–12.

C. Data Collection

Data collection took place between July and August 2020. Before the start of the study, a questionnaire and brief were prepared and submitted to the experts for study feasibility. This meeting will discuss the goals and study design. First, the Primary Investigation Team This opportunity was also used by the Primary Investigation Team to seek supervisor approval. The instructors then unanimously agreed to participate, provided pathways, and facilitated data collection. After giving consent, they had 15–20 min to complete an online questionnaire containing open and closed questions. Finally, the research team used his Google form to create and fill out a questionnaire, a link he distributed to participating students from two Muhammadiya College schools.

D. Data Analysis

Data analysis used descriptive statistics to determine the distribution of independent variables and inferential statistics to explore relationships between independent and dependent variables. Descriptive statistics use counts and percentages, while inferential statistics use independent t-tests and one-way ANOVA to assess mean differences based on independent variables. Pearson's Rank Correlation Analysis helps understand the relationship of student responses to digital literacy. The data description for the dependent variable is the students' digital literacy ability, based on the data results from a questionnaire. Normality-Test is used to test the sample to determine whether the data is typically distributed. In this study, the data used were normality tests using the Kolmogorov-Smirnov method with the help of SPSS software.

Hypothesis testing in testing the effect of the independent Variable Augmented Reality technology based on biology practicum on the variable digital literacy ability. One technique in multivariate analysis is ANOVA. The ANOVA test is a statistical technique used to calculate the significance test of the mean difference between groups simultaneously for two or more dependent variables. A multivariate test tests the effect of the independent variable on the dependent variable. For manual calculations, the multiple correlation coefficient formulae are used. If the test results with inter-subject products are accepted, further testing must be carried out. This test determines the significant difference from the group mean according to the independent variable. Furthermore, a comparison test between the estimated averages was carried out using the least significant difference (LSD) approach—statistical analysis for descriptive, assumption, and hypothesis testing.

3 Results and Discussion

A. Results

The results of the research related to Augmented Reality technology based on biology practicum on the digital literacy ability variable of SMA Muhammadiyah Surabaya City students show that effective learning is implemented through the observation sheet. At the first meeting using Augmented Reality technology based on biology practicum, the average score for each activity four carried out by the teacher at the 1, 2, and 3 meetings were obtained. Therefore, the implementation of the learning is included in the excellent category. In the preliminary process, starting from greetings to bringing up apperception, raise Then it is continued with this activity in the biology practicum process and ends with a closing. Teachers as facilitators always facilitate interaction in improving students' digital literacy skills.

In the Augmented Reality (AR)-based biology practicum process, it is inevitable that students are ready to take biology practicum. The implementation of biology practicum learning scored 4 in the very good category. The next stage is the learning method: dividing students into groups, giving a practicum manual, and the teacher explaining the game's rules or procedure. In this learning activity, the teacher guides and directs students who have not been able to follow the biology practicum learning process as well as possible. Teacher activity in Augmented Reality (AR)-based biology practicum provides an opportunity for groups to discuss AR visualization based on biology practicum capable of delivering education to students' digital literacy. The core activity at each meeting has a score of 4 with a very good category and ends with closing as an evaluation and reflection step.

The teacher took the evaluation step in guiding students to review the entire material in the biology practicum that was carried out during the learning process and reflect on the augmented Reality (AR)-based biology practicum. Students have passed as a way to check students understanding during the learning process. Augmented reality (AR) technology based on biology practicum is required to make an individual report with the provisions already in the manual. The results are uploaded into the school's e-learning. In digital literacy, students follow four indicators that become cultural references, namely understanding the various contexts of digital world users. Cognitive, namely, the power of thinking in assessing content. Constructive, namely the creation of something expert and actual, communicative, understanding the performance of networks and communications in the digital world.

The results of quantitative research data obtained through research with pre-test data are designed with questions that refer to bloom taxonomy and from data analysis on the assumption of Paired T-Test, which is tested for normality. From the normality test based on the pre-test data based on the Q-Q plot, it can be seen as Fig. 1.

From the pre-test normality test based on the Q-Q Plot that the plots that appear to follow the fit line, the variables are normally distributed. Because if the data distribution is not normally distributed, then the allotment of schemes is away from the model (straight line). The diagonal line in this graph represents the ideal state of the data following a normal distribution. The dots around the line are the state of the data being tested. Then from the analysis of the post-test data output based on the Q-Q plot as Fig. 2.

From the pre-test normality test based on the Q-Q plot, the visible plots appear to be fit lines; then, the data is said to be normally distributed. The information is expected because the points follow the regular line or do not spread randomly. Theoretically, a pre-test data set is said to have a normal distribution if the data is spread around the line. Based on the graph above, the interpretation of the output of the test normality with the standard Q-Q plot for the pre-test and post-test values based on a straight line runs from

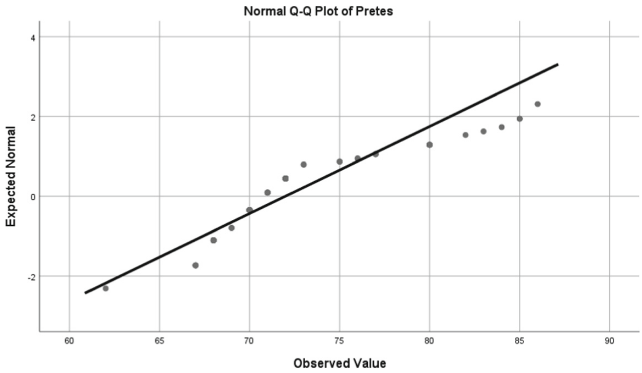

Fig. 1. Normality Test of Pretest Data Based on Q-Q Plot

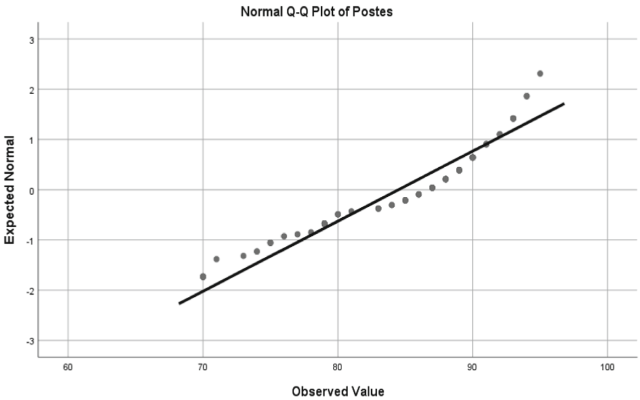

Fig. 2. Normality Test of Pretest Data Based on Q-Q Plot

the lower left corner to the upper right. So that is a form of a diagonal direction called the reference line for normality. Based on the graph above, the pre-test curve and the scattered points approach a straight line; thus, based on the normality test results with a normal Q-Q Plot, it is evident that the experimental and control class learning data are typically distributed.

From the pre-test and post-test normality tests above that have been carried out, it is continued with the paired samples test. A paired t-test is a parametric test used for two paired data. This test aims to determine whether there is a mean difference between two pairs or related samples. Since this is a pair, the data from both samples should be the same amount and come from the same source. Therefore, data consider first that the data have to be normally distributed. Then the pre-test and post-test data can be seen from the results of the analysis as Table 1.

From the Paired Sample T Test, there is an effect of giving pre-test to post-test results because of the value of sig 0.00 < alpha 0.05. This Paired Samples Test table is the output's main table showing the results of the tests. It can be seen from the significance value (2-tailed) in the table. The significance value (2-tailed) of this case

Table 1. The result of Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest - Posttest	−12.505	7.728	.793	−14.080	−10.931	−15.772	94	.000

example is 0.000 ($p < 0.05$). So that the results of the pre-test and post-test experienced significant (meaningful) changes. Based on descriptive statistics, pre-test and post-test proved to be higher post-test. So, it can be concluded that Augmented Reality technology based on biology practicum can improve students' digital literacy. The significance value determines the results of the Paired Sample T Test. This value then determines the decisions taken in this study. Then from the results of the hypothesis analysis, it is assumed that a decision made that the value of sig < 0.05 means that Reject H0 and H1 are accepted, so it concludes that there is a difference in the average pre-test and post-test.

Before proceeding to the ANOVA test, the homogeneity test was carried out first to determine whether the data was homogeneous. Because before the ANOVA test, a pre-requisite test must be carried out, namely homogeneity and normality tests. A homogeneity test is a test to determine whether the variances of two or more distributions are equal. A homogeneity test was conducted to determine whether the data in the variables X and Y were homogeneous or not. The homogeneity test differs from the normality test, although it can be used equally as a requirement in specific parametric tests. The normality test is required in all parametric tests, while the homogeneity test is not always used in parametric tests. This homogeneity test is only used in parametric tests that test the differences between the two groups or several groups with different subjects or data sources. Testing the homogeneity of variance of a data group can be done in several ways based on the number of data groups taken in an experiment. The analysis of the homogeneity test data of digital literacy data is (Table 2).

Table 2. Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Digital Literacy	Based on Mean	2.836	2	92	.064
	Based on Median	2.107	2	92	.127
	Based on Median and with adjusted df	2.107	2	87.780	.128
	Based on trimmed mean	2.662	2	92	.075

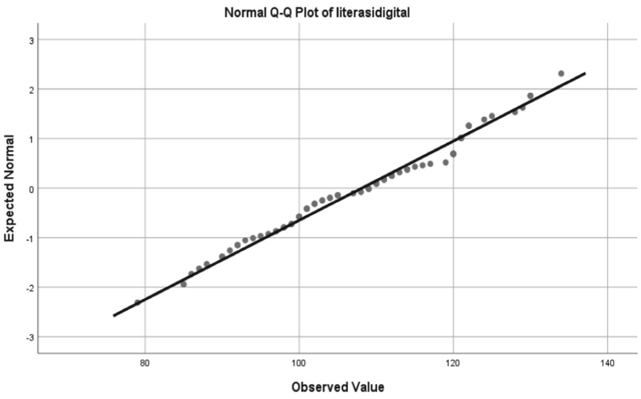

Fig. 3. Normality Test of Digital Literacy Data Based on Q-Q Plot

Following the results of the homogeneity test through the test of homogeneity of variances, the data show to be homogeneous because the significance value is more significant than 0.05 (0.064 > 0.05). This test ensures that the data group comes from the same sample. It means that the analysis results related to the data of students' digital literacy abilities are said to be homogeneous. Then also as one of the pre-requisites for the ANOVA test, namely a normality test based on digital literacy data based on the Q-Q Plot, which can be seen as Fig. 3.

Based on the Q-Q Plot, the pre-test normality test shows that the visible plots appear to be a fit line, and then the data is generally distributed because the data above the point follows the standard line. Based on the graph above, the interpretation of the Q-Q plot for digital literacy values is based on a straight line that runs from the bottom left corner to the top right to form a diagonal direction. Based on the graph above, the pre-test curve and the scattered points approach a straight line; thus, based on the normality test results with a normal Q-Q Plot, it is evident that the experimental and control class learning outcomes data are typically distributed. Followed by the Anova Test with the results of the analysis, namely (Table 3).

Based on the ANOVA output above, it is known that the significance value is 0.003 < 0.05, so it can be said there is a difference or influence of cognitive values on digital literacy. From the results of the Anova analysis above, it can be concluded that there are differences in the cognitive value of the practical-based augmented reality technology

Table 3. Results of ANOVA test Analysis

Digital Literacy					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1776.007	2	888.004	6.313	.003
Within Groups	12941.214	92	140.665		
Total	14717.221	94			

ability on the digital literacy skills of high school students. So, H0 reject, and H1 is accepted. However, the results of the ANOVA are comprehensive and have significant differences. Therefore, to find out whether there were significant differences between groups, the Post Hoc Tests were carried out in Table 4.

From the analysis of digital literacy data through Multiple Comparisons, it can be explained that the value of sig < 0.05 means significant differences between groups. Hence, by looking at the value in the Mean Difference, if there is an asterisk (*), there is a considerable difference. So, it can be concluded that the groups that have an influence or difference are high cognitive and moderate cognitive because of the value of sig $<$ 0.05. Thus, it can be said that the digital literacy ability with the augmented reality technology approach has a significant difference of $0.008 < 0.05$.

B. Discussion

Based on the Paired Sample T Test results, giving the pre-test to the post-test result is an effect because of the value of sig 0.00 $<$ alpha 0.05. This Paired Samples Test table is the output's main table showing the results of the tests. It can be seen from the significance value (2-tailed) in the table. The significance value (2-tailed) of this case example is 0.000 ($p < 0.05$). So, the pre-test and post-test results experienced significant (meaningful) changes. Based on descriptive statistics, pre-test and post-test proved to be higher post-test than pre-test results [30, 31, 44]. Thus, before carrying out the learning process using augmented reality technology based on biology practicum, a pre-test is given first; after that, it is continued with the learning process for a predetermined time allocation, and the last is a post-test. Thus, before carrying out the learning process using augmented reality technology based on biology practicum, a pre-test is given first, after that it is continued with the learning process for a predetermined time allocation, and the last is a post-test [30, 31].

Table 4. Multiple Comparisons

Dependent variable: literacy digital						
LSD						
(I) **Kognitif**	(J) **Kognitif**	**Mean Difference (I-J)**	**Std. Error**	**Sig.**	**95% Confidence Interval**	
					Lower Bound	**Upper Bound**
Low	Currently	– 3.543	4.911	1.000	– 15.52	8.43
	Tall	– 11.477	4.770	.054	– 23.11	.15
Currently	Low	3.543	4.911	1.000	– 8.43	15.52
	Tall	– 7.934*	2.583	.008	– 14.23	-1.63
Tall	Low	11.477	4.770	.054	– .15	23.11
	Currently	7.934*	2.583	.008	1.63	14.23

* The mean difference is significant at the 0.05 level.

Data analysis was carried out not only by the Paired Sample T Test but also by using the ANOVA test. The Anova output obtained is that the significance value is $0.003 < 0.05$, so it can be said there is a difference or influence of cognitive values on digital literacy. From the results of the Anova analysis, it can be concluded that there are differences in the cognitive value of the ability of practical-based augmented reality technology on the digital literacy abilities of high school students [45, 46]. So, H0 is rejected, and H1 is accepted. However, the results of the ANOVA are comprehensive, namely the TNI together, and have significant differences [47, 48]. Then from the analysis of digital literacy data through Multiple Comparisons, it can be explained that the value of sig < 0.05 means significant differences between groups [49, 50] if there is an asterisk (*), then there is a considerable difference [49, 50]. So, it can be concluded that there is an influence or difference is high cognitive and moderate cognitive because of the value of sig < 0.0 5.

Augmented Reality (AR) technology based on biology practicum positively influences students' digital literacy skills [49, 50]. Augmented Reality (AR) is an interactive technology that can project virtual objects into natural objects in real-time. The development of AR technology today has made many contributions to various fields, especially in the learning process [7, 8, 51, 52]. For example, in the field of biology practicum-based learning, AR can be used as a means of learning media, one of which is to introduce fundamental biology practicum into a virtual biology practicum but as if it were in the real world [29, 30, 53]. Moreover, biology learning cannot be separated from observing, exploring, and practicum activities, so Augmented Reality (AR) is a technology that can solve the problems being faced in learning [30, 31].

Augmented Reality (AR) is a technology in the form of an application that combines the real world with the virtual world in two-dimensional and three-dimensional structures simultaneously projected in a natural environment [44]. Augmented Reality technology adds virtual objects to real objects at the same time [54, 55]. The existence of Augmented Reality (AR) can be a solution to science learning problems, especially to display learning objects in the classroom to be more interactive, efficient, and practical [28, 54]. Then Augmented Reality (AR), which can be widely implemented in various media, is easy to operate, and low-cost manufacturing makes Augmented Reality (AR) a learning media solution in the period of adapting to new habits [30, 53]. Then it became one of the interactive technologies used in biology learning [30, 53].

This research aims to discover the role of Augmented Reality (AR) technology as a learning media solution for biology practicum during the adaptation period of new habits [30, 31, 53]. The use of technology in supporting the learning process is growing along with the development of Augmented Reality (AR) technology, one of which is an android application on smartphones [44, 54]. Of course, if biology lessons can be delivered using this technology, the learning process will be more exciting and motivate students to excel [2, 4]. Then AR technology provides habits for improving students' digital literacy through the learning process [7, 8, 55].

Digital literacy does not only refer to operating skills and using various information and communication technology tools but also to the process of reading and understanding the content of technological devices and the process of creating and writing new knowledge [33, 34, 56]. Information can be new knowledge that can be easily obtained and disseminated at a rapid rate to users who access it [45, 57]. Therefore, digital literacy is essential in developing the learning process, especially in the biology practicum learning process. Digital literacy is one of the six basic literacy applied mainly in learning activities [7, 28, 52]. Digital literacy can be grown with biology practicum-based learning using augmented reality (AR) technology [7, 28, 52].

AR technology based on biology practicum has a virtual appearance. It is an application that combines the real world with the virtual world in a two-dimensional and three-dimensional structure projected in a real environment simultaneously to increase digital literacy [29, 30]. Digital literacy is one type of literacy of various kinds of literacy advancements that have emerged against technological developments and advances [31, 44]. Digital literacy is one of the student's skills in understanding digital content [44, 54, 55]. Today's digital literacy makes it easier for people to be wiser in using and accessing technology [51, 52, 57]. In addition, digital literacy is used to demonstrate a fundamental aspect of new media, namely digitization [7, 29, 52, 53]. As a result, students' digital literacy achievement is obtained [30].

4 Conclusion

From the research results that researchers have carried out, it can be concluded that the Paired Sample T-Test analysis influences pre-test to post-test results because of the value of sig 0.00 < alpha 0.05. It can be seen from the significance value (2-tailed) in the table. The significance value (2-tailed) of this case example is 0.000 ($p < 0.05$). So that the results of the pre-test and post-test experienced significant (meaningful) changes. Then, based on the Anova output above, it is known that the significance value is 0.003 < 0.05, so it can be said there is a difference or influence of cognitive values on digital literacy. From the results of the Anova analysis above, it can be concluded that there are differences in the cognitive value of the practical-based augmented reality technology ability on the digital literacy skills of high school students. So, H0 is rejected, and H1 is accepted. However, the results of the ANOVA are comprehensive and have significant differences. From the analysis of digital literacy data, it can be explained that the value of sig < 0.05 means that there are significant differences between groups. By looking at the value in the Mean Difference, if there is an asterisk (*), there is a significant difference.

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