The Effectiveness of the Augment Reality (AR)-Based Project Citizen Learning Model to Improve the Digital Quality Culture (QCD) of Elementary School Students in North Sumatra

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Abstract

This study was conducted to test the effectiveness of the Augmented Reality (AR)-based Project Citizen learning model in improving the Digital Quality Culture (QCD) of elementary school students in North Sumatra. The purpose of this study was to find out how effective the Augmented Reality (AR)-based Project Citizen learning model is in improving students' Digital Quality Culture (QCD). The method used was a quantitative research approach with the Pre-Experiment Type experiment and the One-Group Pretest-Posttest Design plan. The instruments used in this study were Pre-Test and Post-Test questions. Based on the results of the analysis that has been carried out, it proves that there is a significant increase between the Pre-Test and Post-Test values with an average difference of 13.28 points with (Sig. 2 tail) of 0.000 which indicates that the Augmented Reality-based Project Citizen learning model is effective in improving students' Digital Quality Culture. Thus, it can be concluded that the Augmented Reality-based Project Citizen model is an effective learning model applied in improving the Digital Quality Culture of elementary school students in North Sumatra.

Keywords: Citizen Project, Augmented Reality, Digital Quality Culture.

In the era of Society 5.0, technological advances, especially in the field of Artificial Intelligence (AI), have had a great impact on various aspects of life, including education. This ever-evolving technology offers opportunities to improve the quality and effectiveness of learning (Ais Isti'ana, 2024; Siringoringo & Alfaridzi, 2024). Teachers as educators must be able to show empathy and adapt to the progress of the times by developing relevant learning models so that education remains effective and in accordance with the needs of students (Dewi et al., 2023; Hadar et al., 2020). Transformation in education today requires a paradigm shift from a teacher-centered learning model to a more student-focused approach (Goodwin, 2024;

Lembong et al., 2023). Millennials and Generation Z, with Quality Culture Digital unique, thus affecting the way students interact with technology and information. Quality Culture Digital This includes students' ability to use technology effectively, understand and analyze digital information, and behave ethically in cyberspace.

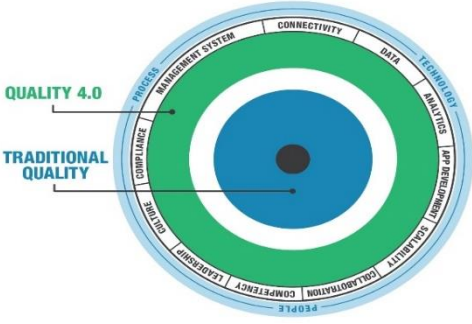

Figure 1. Elements of Digital Quality Culture

The learning process needs to be adapted so that students learn actively and independently, utilizing digital tools and resources to deepen students' understanding (McKnight et al., 2016; Sari et al., 2024). In this case, the learning model Project Citizen berbasis Augmented Reality (AR) is an innovative solution. Project Citizen is a problem-based learning model that emphasizes contextual practice and helps students understand citizenship theory through hands-on experience (Akirav, 2023; Fasya & Wiranti, 2024; Mulyani et al., 2023). Using AR, the model integrates virtual elements into the real world, allowing students to interact with information in visual or 3D format through a mobile app. This not only enriches the learning experience but also supports the active engagement of students.

At Public Elementary School 101774 Sampali Deli Serdang Regency and IT Private Elementary School Al Fauzi Medan City, the application of the Project Citizen learning model based on Augmented Reality (AR) has been carried out to improve the Quality of Digital Culture (QCD) of students. Initial observations show that students in these two schools show high enthusiasm and involvement in learning. At Public Elementary School 101774 Sampali, grade V students have made significant progress in their understanding of digital materials and skills, which reflects the improvement of Digital Culture Quality. However, at IT Private Elementary School Al Fauzi, despite the improvement in the quality of learning, students face technical obstacles and difficulties in adapting to Augmented Reality technology, which has an impact on the process of improving the quality of students' Digital Culture. The following is a table of the results of observations in class V that have been carried out:

Table 1. Results of Observation Recording

School Name	Number of Students	Enthusiasm	Involvement	Progress in Material Understanding	Digital Skills	Obstacles and Difficulties
Public Elementary School 101774 Sampali	33	85%	80%	90%	88%	-
IT Private Elementary School Al Fauzi	30	80%	75%	70%	73%	Technical constraints, adaptation of AR technology

Based on the observation recap table that has been carried out, the results of the implementation of the Project Citizen learning model based on Augmented Reality (AR) at

Public Elementary School 101774 Sampali and IT Private Elementary School Al Fauzi show significant findings. At Public Elementary School 101774 Sampali, out of 33 students in grade V, around 85% of students showed high enthusiasm for AR-based learning. Student involvement in learning activities was also excellent, with 80% of students actively participating. Progress in material comprehension has been very positive, with 90% of students making significant progress. In addition, students' digital skills improved well, with 88% of students showing skill improvement. There are no reported obstacles or difficulties in the application of AR technology in this school.

On the other hand, at IT Private Elementary School Al Fauzi, out of 30 students in grade V, around 80% of students showed high enthusiasm for this learning model, while 75% of students were actively involved in learning activities. Despite the improvement in material comprehension, only 70% of students experienced significant progress. An increase in digital skills was also noted, with 73% of students showing progress. However, in this school there are several technical obstacles and difficulties in adapting to AR technology, which affect the process of improving the Quality Culture Digital (QCD) of students. Overall, the implementation of the AR-based Project Citizen learning model showed positive results in both schools, despite differences in the level of progress and obstacles faced. These results reflect the great potential of AR technology in improving students' Digital Culture, but also emphasize the need to pay attention to technical challenges and adapt to ensure optimal effectiveness.

Augmented Reality (AR) serves as an interactive learning medium that combines the real and virtual worlds, creating an instructional environment that supports active student engagement and collaboration (AlGerafi et al., 2023; Papanastasiou et al., 2019; Rhea & Bauml, 2020). Using an app like Assemblr Studio, students can access additional information by scanning an object or QR code (Quick Response), which allows students to obtain more detailed and contextual information. With the approach Project Citizen AR-based, students not only learn theory but also engage in relevant and applicable practical processes. This model is designed to improve Quality Culture Digital (QCD) students by integrating technology in the daily learning process.

Research Methods

This study uses the Quasi-Experiment Design method, which is a form of experimental design that involves a control group but cannot fully control external variables that affect the implementation of the experiment.

The design of this study uses a Nonequivalent Control Group Design, with the following design.

Table 2. Nonequivalent Control Group Design

Group	Pre-Test	Treatment	Post-Test
Experiment	O1	x	O2
Control	O3	-	O4

Information:
O1 and O3 = Pre-Test measurements for the experimental and control groups.
X = Learning using Models Project Citizen berbasis Augment Reality.
O2 and O4 = Post-Test measurements for the experimental and control groups.

The variables of this study consist of two variables, namely X and Y. Variable X is an independent variable, namely the Project Citizen model based on Augment Reality and Variable Y

is a bound variable in this study, namely Digital Quality Culture.

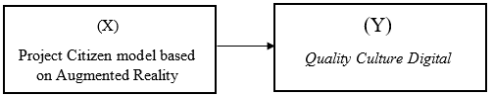

Figure 2. Research Variables

This research was carried out at Public Elementary School 101774 Sampali and IT Private Elementary School Al Fauzi. This research was carried out from July 1 to August 12, 2024. The sampling technique in this study used Simple Random Sampling; strata in the population was not taken into account when selecting samples from the population. Each class in the population has an equal chance of being selected as a sample when using this strategy. The two classes that were selected were class V of Public Elementary School 101774 Sampali, which had 33 students as an experimental class, and class V of IT Private Elementary School Al Fauzi, which had 30 students as a control class, so that the total sample of this study was 63 students.

The data collection technique in this study involves three main methods of testing, documentation, and observation. The test is used to measure the extent of students' improvement in Digital Quality Culture (QCD), providing a quantitative picture of students' skills and understanding through Pre-Test (initial assessment) and Post-Test (final assessment) using practical assessments. Of the 30 points of assessment indicators created by the researcher, only 24 points are considered valid and reliable to be used in the Pre-Test and Post-Test after the validation process. Documentation is used to collect and store data related to the learning process and outcomes, including records of activities and materials used during the experiment. Observations were carried out to obtain qualitative data on student interaction with the learning model, as well as to assess the level of student enthusiasm and engagement. In addition, the assessment also involved a questionnaire filled out by observers to gain insight into the effectiveness of implementing the Project Citizen learning model based on Augmented Reality (AR) in improving the Quality Culture Digital (QCD) of students.

The data analysis method in this study uses SPSS (Statistical Package for the Social Sciences) software version 21. The analysis was carried out including validity, reliability, and homogeneity tests using the Fisher Test. The normality test was carried out with the Lilliefors test. In addition, the analysis includes the calculation of Effect Size and N-Gain, as well as hypothesis testing using t-tests.

The normalized gain formula uses the following methods to determine the improvement of student learning outcomes:

$$\text{Normalized gain (g)} = \frac{posttest\ score - pretest\ score}{ideal\ score - pretest\ score}$$

Table 3. Normalized Gain Interpretation (G) Modified

Normalized Gain Value	Interpretation
-1.00≤g>0.00	There is a decline
g = 0.00	No increase
0,00<g<0,30	Low
0,30≤g<0,70	Medium
0.70≤g≤1.00	High

The following categories apply to the criteria used to determine the effect size:

Tabel 4. Category: Effect Size

Effect Size	Category
d<0,2	Low
0,2<d<0,8	Medium
d>0,8	High

Before being used for research, the instrument must be tested for validity and reliability first, so that it is proven valid and reliable as a measuring tool for Digital Culture Quality. In this case, the instrument item is said to be valid if the significance value is less than

0.05 (sig<0.05), the instrument item is said to be invalid if the significance value is greater than 0.05 (sig>0.05). The following are the results of the validity test of indicator items:

Table 5. Results of the Validity Test of Assessment Indicators

No Indicator	Significance	Information
1	0,001	Valid
2	0,000	Valid
3	0,001	Valid
4	0,000	Valid
5	0,001	Valid
6	0,000	Valid
7	0,001	Valid
8	0,000	Valid
9	0,000	Valid
10	0,000	Valid
11	0,001	Valid
12	0,000	Valid
13	0,000	Valid
14	0,000	Valid
15	0,000	Valid
16	0,854	Invalid
17	0,976	Invalid
18	0,883	Invalid
19	0,000	Valid
20	0,000	Valid
21	0,691	Invalid
22	0,000	Valid
23	0,001	Valid
24	0,000	Valid
25	0,0976	Invalid
26	0,000	Valid
27	0,951	Invalid
28	0,000	Valid
29	0,000	Valid
30	0,000	Valid

24 of the test findings of the instrument were considered valid, while 6 were considered invalid based on the results of the validity test listed in the table. As a result, 24 valid indicators can be used as a measuring tool to assess the Quality of students' Digital Culture.

In order for a test to produce reliable results, its reliability level must be high. A valid test must be reliable, but a test can have reliability without always being valid. To evaluate the consistency of the indicator, the researcher used a reliability test with the formula Cronbach Alpha. Data for reliability tests Cronbach alpha, an instrument is considered reliable if the Cronbach alpha value is more than 0.60 (Sugiyono, 2019). The table below displays the reliability test findings of the instrument:

Tabel 6. Reliability Statistics

Cronbach's Alpha	N of Items
.983	24

Table 6 shows that the reliability test of the exam question instrument produced an r11 score of 0.983, which is much greater than 0.60 (0.983 > 0.60). Thus, the indicator instrument to measure students' Digital Culture Quality assessment meets the high reliability requirements, as indicated by the high reliability score in Table 6.

The researcher chose to use 24 of the 30 test questions for the hypothesis test, which is the final test, after conducting a validity and reliability test analysis of all 30 Digital Quality Culture test questions. Of the 30 questions, 6 did not meet the requirements for discriminating power. Therefore, this study uses the following set of questions: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 19, 20, 22, 23, 24, 26, 28, 29, and 30. Based on the results of validity and reliability testing, these 24 questions are considered to meet good standards and are suitable to be used as a measure of students' Digital Culture Quality.

Results and Discussion

Result

In the application of learning, the Project Citizen model based on Augmented Reality (AR) has proven to be more effective in improving the Digital Culture Quality of students compared to the use of the conventional Project Citizen model. In the experimental class, learner-centered learning with the educator acting as a facilitator who supports and implements all predetermined steps using the Augmented Reality-based Project Citizen model. The results

of the research from each meeting can be seen in the table below:

Table 7. Learning Implementation Results Using the Project Citizen Model based on Augmented Reality

Implementation	Percentage (%)
Meeting 1	80%
Meeting 2	83%
Meeting 3	89%
Meeting 4	92%
Meeting 5	95%
Meeting 6	97%
Meeting 7	100%

Table 7 presents the results of the analysis of the application of the Augmented Reality (AR)-based Project Citizen model in the learning process. This data was obtained from observation sheets filled out by class teachers as observers during the research project. Based on these findings, the estimated learning management showed a progressive increase from meeting to meeting: at the first meeting it was recorded at 80%, increasing to 83% at the second meeting, 89% at the third meeting, 92% at the fourth meeting, 95% at the fifth meeting, and reaching 97% at the sixth meeting. At the last meeting, the estimated learning management reached 100%.

The findings from the pretest and posttest in the control class and the experimental class show the results obtained from the application of the Project Citizen model based on Augmented Reality. The following is a recapitulation of the pretest and posttest scores of the control class and the experimental class:

Table 8. Recapitulation of Pretest and Posttest Scores

Indicator	Class			
	Experiment		Cholesterol	
	Pretest	Posttest	Pretest	Posttest
Total Value	1191	2031	961	1741
Average	49,62	84,62	40,04	71,54

Through this table, a graph can be generated to find out a broader histogram picture of the results of the pretest and Posttest, the following are the pretest and posttest graphs:

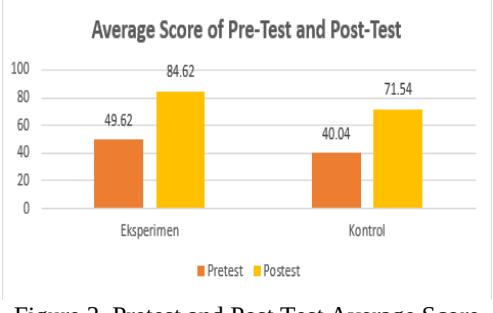

Figure 3. Pretest and Post Test Average Score Graph

The results showed that the experimental class had a higher average score of pretest and posttest than the control group, as seen in the graph above. In the experimental class, the average score of the pretest was 49.62, while in the control group it was 40.04. After the posttest, the average score of the experimental class rose to 84.62, while the average score of the control class was 71.54.

It can be seen from the results of the pretest and posttest of the experimental class that have experienced a significant increase, that the use of the Project Citizen model based on Augmented Reality (AR) can improve the Quality of students' Digital Culture.

Normality Test (Liliefors Test)

The Liliefors test, especially with a significance threshold of $\alpha = 0.05$, is a normative test used in this study. The sample is normally distributed if Lcounts < Ltable Ha is accepted, and does not have a normal distribution if Lcounts > Ltable Ha is rejected. The normality test calculation is based on criteria to determine whether the data is normally distributed or not.

Table 9. Below shows the results of the pre-test and post-test normality tests:

Table 9. Results of the Pretest and Posttest Normality Test of the Experimental and Control class

Statistics	Experiment		Control	
	Pretest	Posttest	Pretest	Posttest
N	33	33	30	30
$\bar{x}$	49	84	40	71
SD	18,83	83,91	16,39	76,45
L_{Count}	0,138	0,146	0,152	0,159
L_{table}	0,154	0,154	0,161	0,161
Conclusion	Normal	Normal	Normal	Normal

Table 9 above shows that the L numberof experimental classes is distributed regularly, with pretest results of 0.138 and postes findings of 0.146. The L numberof control class counts was also distributed normally, although the control class pre-test and post-test scores were 0.152 and 0.159, respectively. Similarly, the results of both classes can meet the requirement that Lcounts < Ltable, which indicates that the distribution of both classes in the pre-test and post-test is normally distributed.

Normality Test (Kolmogorov-Smirnov Test One-Sample Test)

Traditional requirements tests or assumption tests for data analysis include normality tests. This means that the normality of the distribution of the research data must be checked before conducting statistical analysis to test the hypothesis i.e., regression analysis. Data that is regularly dispersed is considered good data. The Kolmogorov-Smirnov normality test relies on the following principles to draw conclusions: If the significance value (Sig.) of a study is greater than 0.05 then the data is considered to be regularly distributed; and if the Sig value is less than 0.05, then the research data is not normally distributed.

Table 10. One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		63
Normal Parameters [a, b]	Mean	.0000000
	Std. Deviation	2.92713942
Most Extreme Differences	Absolute	.199
	Positive	.076
	Negative	-.188
Test Statistic		.188
Asymp. Sig. (2-tailed)		.188c

The significance value of the Asymp variable of product quality. Sig (2-tailed) is higher than 0.05 i.e., 0.188, according to the resulting SPSS output table. The data are normally distributed, according to the conclusions drawn from the Kolmogorov-Smirnov normality test described above.

Multicholinearity Test

Basis for Making Inferences from Multicollinearity Tests (VIF and Tolerance) It is a common fact that all statistical tests must have a basis to draw conclusions. The following is the basis for inferences made in multicollinearity tests using tolerances and VIFs: If the VIF value of the regression model is less than 0.10, it indicates that multicollinearity does not exist; If the value is more than 0.10, multicollinearity occurs.

Table 11. Multicollinearity Test

Coefficients[a]			
Model		Collinearity Statistics	
		Tolerance	VIF
1	(Constant)		
	Project Citizen based on Augmented Reality (X)	.684	.068
a. Dependent Variable: Quality Culture Digital			

By looking at the Tolerance and VIF values, multicollinearity test decisions can be made. The coefficient for the variable (X) is less than 0.10, according to the 'Coefficients' output table in the 'Collinearity Statistics' section. The VIF value

for variable (X) is less than 0.10, which is 0.068 with a tolerance of 0.684. It can be said that there are no signs of multicollinearity in this regression model based on the decision-making criteria of the multicollinearity test.

Heteroscedasticity Test

The heteroscedasticity test was used to determine whether the residual variance of the regression model was different or similar between the data. This test is called homoscedasticity if the residual variance between observations is constant; It is called heteroscedasticity if it varies. Regression models that meet the conditions of homoscedasticity are considered good. The presence or absence of a particular pattern on a scatter chart can be used to determine whether heteroscedasticity is present. When a particular pattern emerges, heteroscedasticity has occurred. However, heteroscedasticity does not exist if there is no visible pattern and the dots stretch above and below the zero value of the Y-axis.

It can be seen from the figure above that the findings of the scatter plot of the heteroscedasticity test meet the heteroscedasticity requirements. This can be seen from the scatter plot above, where the dots are erratic and do not follow a certain pattern. Therefore, it can be said that the data is heteroscedastic-free or does not show heteroscedasticity.

Homogeneity Test

After the data is distributed normally, a homogeneity test is carried out. The Fisher test is used as a homogeneity test. The attachment displays the results of the data homogeneity test calculation. Homogeneous samples if Fcounts < Ftable Ha is declared accepted; non-homogeneous samples if Fcounts > Ftable Ha is rejected. This criterion is used to determine whether the data is homogeneous or not. Table 12. Below are the results of homogeneity tests for pretest and posttest:

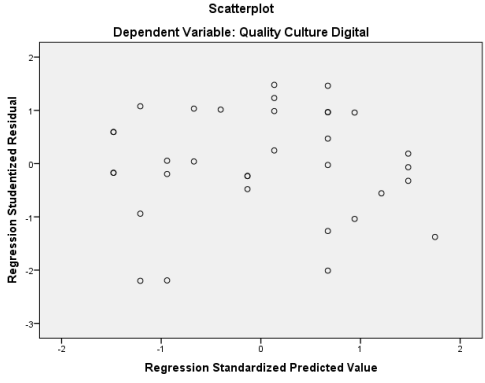

Figure 4. Scatterplot Heteroscedasticity Test

Table 12. Results of Pretest and Posttest Homogeneity Test for Experimental and Control classes

Statistics	Pretest		Posttest	
	Experiment	Control	Experiment	Control
F_{count}	2,1846		1,8376	
F_{table}	3,9984		3,9984	
Conclusion	Homogeneous		Homogeneous	

The results of the homogeneity test for pretest and posttest in the control and experimental classes are shown in Table 12 above. The pretest of the experimental and control classes produced an F valueof 2.1846, while the posttest of the experimental and control classes produced an Fof 1.8376. Since the Fcount < Ftable was found for data from both classes, it can be said that both samples have the same variance and are homogeneous.

Uji Hipotesis (Uji t)

It has been determined through the necessary data analysis test that the test result data of each class is homogeneous and distributed in a regular manner. Thus, data analysis can be continued to the next stage, namely hypothesis testing, to ascertain the presence or absence of influence. With the following conditions, the t test is used to test this hypothesis: Ha is accepted if tcounts > ttable and is rejected if tcounts < ttable. Table 13. Below displays the results of the hypothesis test for the experimental and control classes:

Table 13. Hypothesis Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	49.348	11.343		1.988	.005
	Project Citizen based on Augmented Reality	.087	.186	.058	2.439	.000

a. Dependent Variable: Quality Culture Digital

The table shows that the results of the hypothesis test show that the calculated t value is greater than the ttable, which is (2,439 > 1,670). So Ha is accepted and Ho is rejected, meaning that based on the results of the hypothesis test, the use of the Project Citizen model based on Augmented Reality has a significant effect on the Quality of students' Digital Culture.

Determination Coefficient Analysis (R2)

The value of the determination coefficient can be seen as the degree of contribution of the independent variable to the dependent variable or as the amount that can be explained by the independent variable to the variance of the dependent variable. The percentage of variance described by the independent variable (X) relative to the dependent variable (Y) is known as the coefficient of determination (R squared or R-squared), denoted by "R^2". In other words, the coefficient of determination, also known as R squared, can be used to forecast and determine the extent to which variable X contributes to variable Y simultaneously or collectively.

Table 14. Coefficient of Determination

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.413	.334	.278	2.199

a. Predictors: (Constant), Project Citizen based on Augmented Reality (X)

b. Dependent Variable: Quality Culture Digital

It is known that the R Square value is 0.334 and the determination coefficient or R is 0.413 based on the SPSS output table "Model Summary" above. The coefficient of determination (R) has a magnitude of 0.413 or 41.3%. This graph shows that there is a partial influence of 41.3% of the Augmented Reality-based Project Citizen variable on the Digital Culture Quality variable at Public Elementary School 101774 Sampali Deli Serdang Regency and IT Private Elementary School Al Fauzi Medan City. While variables that are not included in this regression equation or variables that are not studied affect the remaining 100% - 41.3% = 58.7%.

N-Gain

Digital Culture Quality of students is marked by a gain value, gain is the difference between posttest and pretest scores, gain shows an

improvement in students' abilities after the learning process. The normalized NGain test was carried out to show how much the Digital Culture Quality of students improved after participating in learning with the Project Citizen model based on Augmented Reality. The calculation of N-Gain is the difference between the posttest and pretest scores divided by the difference between the highest score and the pretest score. The following are the results of the N Gain score in the experimental class:

Table 15. Experimental Class N-Gain

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	33	.30	,100	.8462	.24902
Ngain_Persen	33	30.00	100.00	84.6286	24.90274
Valid N (listwise)	33				

The table is known as the result of the N-Gain Score value of 0.8462, the value is greater than 0.3 (0.84>0.3), then the category obtained is high/high effectiveness. N-Gain Percent mean value of 84.6286, the value is greater than 76% (84%>76%), so it is interpreted as effective. So it can be concluded that the use of the Project Citizen model based on Augmented Reality to improve the Quality of Digital Culture of students has proven to be effective in experimental and high-category classes.

The results of the N Gain test in the control class are presented in the following table:

Table 16. N-Gain Control Class

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	30	.30	,100	.7154	.23522
Ngain_Persen	30	30.00	100.00	71.5444	23.52174
Valid N (listwise)	30				

The table is known to have a N-Gain Score value of 0.7154, the value is greater than 0.3 (0.71>0.3), then the category obtained is high/high effectiveness. N-Gain Percent mean value 71.5444, and is categorized as moderate.

Effect Size

In this study, effect measures were used to measure how well one variable affected another. The efficacy of the Project Citizen model based on Augmented Reality on Digital Culture Quality was assessed using the Effect Size test. The following table shows the results of the Effect Size calculations:

Table 17. Effect Size Results

Class	Average Gain	SD	Effect Size	Category
Experiment	84.6286	24,9027	0,2	Keep
Control	71,5444	23,5217		

The results of the effect size calculation showed that the use of the Project Citizen model based on Augmented Reality could be used to improve the Digital Culture Quality of students, with a value of 0.2 indicating the effectiveness of this model to have a moderate categorical effect on the Digital Culture Quality of students.

Discussion

Based on the results of the analysis and research that has been carried out, it can be proven that the Project Citizen learning model based on Augmented Reality (AR) is effective in improving the Quality Culture Digital (QCD) of elementary school students in North Sumatra. This is supported by an effect size value of 0.2, which indicates a medium category. This proves that the application of the model has a significant impact on improving the Quality of Digital Culture of students, even though it is not included in the large category. The success of the AR-based Project Citizen model in improving Digital Culture Quality needs to be seen from the perspective of practical implementation in the field. This approach is adopted by educators by adapting learning content according to the local context and student needs. In the process, students respond well to the use of AR technology, which makes students more engaged and motivated in learning.

The AR-based Project Citizen model is designed so that students not only understand digital concepts, but are also able to apply them in real-life contexts that are relevant to students.

As in learning about environmental issues, students can use AR to simulate the impact of students' actions on the surrounding environment, which helps students understand and appreciate the importance of their role as responsible citizens. The application of AR in the Project Citizen model not only helps students understand the material better, but also fosters an appreciation for digital technology and how to use it responsibly. Students' response to this model is an important indicator of their success. Based on observations and assessments conducted during the study, students showed a significant increase in learning motivation. Students become more active in class discussions, more enthusiastic in completing given projects, and more critical in providing solutions to the problems they face.

This improvement shows that the AR-based Project Citizen model not only improves Digital Culture Quality, but also creates a more dynamic and interactive learning environment. Institutional and cultural support of the school also plays an important role in the successful implementation of this model. The elementary school where the research was conducted is committed to integrating technology in every aspect of learning, from the curriculum to teaching methods. This support ensures that the implementation of the AR-based Project Citizen model is carried out consistently and sustainably, allowing students to experience the full benefits of this approach in the long term.

These findings are in line with various relevant studies that have been conducted previously, showing that the application of technology-based learning models can significantly improve Quality Culture Digital student (Alakrash & Razak, 2021; Nurunisa & Shodiq, 2024; Rasdiana et al., 2024). The research revealed that integrating technology with real-world contexts helps strengthen students' understanding and critical skills. Technology-based approaches such as AR can increase student motivation and engagement in the learning process, as well as improve students' digital skills and creativity (Wang, 2020). Technology-based learning models assist students in connecting different concepts, which contributes to the improvement of critical thinking and problem-solving skills (Dominggus et al., 2021; Simanjuntak et al., 2021). The integration of technology in the curriculum not only improves students' understanding of the material, but also strengthens students' analytical and critical thinking skills (Murillo-Zamorano et al., 2019).

Conclusion

Based on the results of research and data analysis, it can be concluded that the Quality of Digital Culture (QCD) of students can be improved through the application of the Project Citizen model based on Augmented Reality (AR). This can be seen from the comparison of pretest and posttest scores in the experimental class, where the pretest score of 49.63 increased significantly to 84.63 in the posttest. As a comparison, the pretest and posttest scores in the control class remained at a lower level compared to the experimental class, with a pretest score of 40.04 and posttest 71.54. The results of the hypothesis test showed that the calculated t value was greater than the ttable, which was (2,439 > 1,670). In case, Ha is accepted and Ho is rejected, with an effect size of 0.2 which is included in the medium category, at a significance level of $\alpha = 0.05$. Therefore, it can be concluded that the AR-based Project Citizen model is effective in improving the Digital Culture Quality of students in elementary schools in North Sumatra.

WORKS CITED

Ais Isti'ana. (2024). Integrasi Teknologi dalam Pembelajaran Pendidikan Islam. Indonesian Research Journal on Education : Jurnal Ilmu Pendidikan, 4(1), 302 – 310.

Akirav, O. (2023). Active Civic Education Using Project-Based Learning: Israeli College Students' Attitudes towards Civic Engagement. Interdisciplinary Journal of Problem-Based Learning, 17(1).

Alakrash, H. M., & Razak, N. A. (2021). Technology-based language learning: Investigation of digital technology and digital literacy. Sustainability (Switzerland), 13(21). https://doi.org/10.3390/su132112304

AlGerafi, M. A. M., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the Potential: A Comprehensive Evaluation of Augmented Reality and Virtual Reality in Education. Electronics (Switzerland), 12(18). https://doi.org/10.3390/electronics12183953

Dewi, A. C., Salsabila, Jannah, M., Cantika, A. Z., Aurora, F., & Amirah, A. (2023). Menelusuri Jejak Guru Ideal di Era Digital. PENDIRI: Jurnal Riset Pendidikan, 1(1), 1–8.

Dominggus, R., Kristin, S., Martha M, B., Since Y, K., Vera V, K., & CorneliLatu, P. (2021). Resource based learning design thinking (RBLDT): A model to improve students' creative thinking skills, concept gaining, and digital literacy. Cypriot Journal of Educational Sciences, 16(1), 288–302.

Fasya, N. A., & Wiranti, D. A. (2024). Efektivitas Model Project Citizen untuk Meningkatkan Kemampuan Literasi Budaya Peserta Didik pada Pembelajaran Pendidikan Pancasila Kelas 5 SDN 2 Tahunan. 4, 930–942.

Goodwin, J. R. (2024). What's the Difference? A Comparison of Student-Centered Teaching Methods. Education Sciences, 14(7), 736. https://doi.org/10.3390/educsci14070736

Hadar, L. L., Ergas, O., Alpert, B., & Ariav, T. (2020). Rethinking teacher education in a VUCA world: student teachers' social-emotional competencies during the Covid-19 crisis. European Journal of Teacher Education, 43(4), 573–586. https://doi.org/10.1080/02619768.2020.1807513

Lembong, J. M., Lumapow, H. R., & Rotty, V. N. J. (2023). Implementasi Merdeka Belajar Sebagai Transformasi Kebijakan Pendidikan. Jurnal Educatio FKIP UNMA, 9(2), 765–777. https://doi.org/10.31949/educatio.v9i2.4620

McKnight, K., O'Malley, K., Ruzic, R., Horsley, M., Franey, J. J., & Bassett, K. (2016). Teaching in a digital age: How educators use technology to improve student learning. Journal of Research on Technology in Education, 48(3), 194–211. https://doi.org/10.1080/15391523.2016.1175856

Mulyani, S., Yogiarni, T., Caturiasari, J., & ... (2023). Pelatihan Model Pembelajaran Project Citizen Bagi Guru-Guru di Sekolah Indonesia Johor Bahru, Malaysia Untuk Meningkatkan Civic Literacy. … & Education …, 3(2), 84–92.

Murillo-Zamorano, L. R., López Sánchez, J. Á., & Godoy-Caballero, A. L. (2019). How the flipped classroom affects knowledge, skills, and engagement in higher education: Effects on students' satisfaction. Computers and Education, 141(October 2018). https://doi.org/10.1016/j.compedu.2019.103608

Nurunisa, F. A., & Shodiq, S. F. (2024). Developing Quality Social Relationships : Technology-Based Learning Model to Enhance Social Skills in Boarding Schools. 5(3), 364–372. https://doi.org/10.46843/jiecr.v5i3.1537

Papanastasiou, G., Drigas, A., Skianis, C., Lytras, M., & Papanastasiou, E. (2019). Virtual and augmented reality effects on K-12, higher and tertiary education students' twenty-first century skills. Virtual Reality, 23(4), 425–436. https://doi.org/10.1007/s10055-018-0363-2

Rasdiana, Wiyono, B. B., Imron, A., Rahma, L., Arifah, N., Azhari, R., Elfira, Sibula, I., & Maharmawan, M. A. (2024). Elevating Teachers' Professional Digital Competence: Synergies of Principals' Instructional E-Supervision, Technology Leadership and Digital Culture for Educational Excellence in Digital-Savvy Era. Education Sciences, 14(3). https://doi.org/10.3390/educsci14030266

Rhea & Bauml, 2018. (2020). education sciences Active Learning Augmented Reality for STEAM Education — A Case Study. 1–15.

Sari, H. D., Riandi, R., & Surtikanti, H. K. (2024). Bahan Ajar Digital Bermuatan Potensi Lokal Untuk Meningkatkan Pemahaman Konsep dan Motivasi Belajar Pada Materi Bioteknologi Konvensional. Jurnal Basicedu, 8(1), 263–276. https://doi.org/10.31004/basicedu.v8i1.6503

Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021). Effectiveness of problem-based learning combined with computer simulation on students' problem-solving and creative thinking skills. International Journal of Instruction, 14(3), 519–534. https://doi.org/10.29333/iji.2021.14330a

Siringoringo, R. G., & Alfaridzi, M. Y. (2024). Pengaruh Integrasi Teknologi Pembelajaran terhadap Efektivitas dan Transformasi Paradigma Pendidikan Era Digital. Jurnal Yudistira: Publikasi Riset Ilmu Pendidikan Dan Bahasa, 2(3), 66.

Sugiyono. (2019). Metode Penelitian Kuantitatif, Kualitatif dan R & D. Penerbit; Alfa Beta, Bandung.

Wang, Y. H. (2020). Integrating games, e-books and AR techniques to support project-based science learning. Educational Technology and Society, 23(3), 53–67.