

Impact of Adaptive Educational Game Applications on Improving Student Learning: Efforts to Introduce Nusantara Culture in Indonesia

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Abstract

This study aimed to introduce Nusantara culture based on educational games by adjusting students' learning styles. Culture as an ancestral heritage tradition needs to be preserved by introducing it to the younger generation from an early age. However, the survey results found that less than 26% of student respondents understood Nusantara culture well. Compared to previous research, the model of cultural introduction through adaptive educational games is more fun because it is adapted to the way students learn. This research was carried out using the Design-Based Research (DBR) method through 4 stages of the procedure. The feasibility test and application effectiveness test were carried out on a group of students from several elementary schools in Indonesia, who were selected using a cluster random sampling technique. The results of media design and content validation obtained an average value of 0.76 and 0.82, which means that the media are declared valid. The feasibility test used the System Usability Scale (SUS) with an average value of 80% in the acceptable category. The results of the research obtained a description of the comparison of the final scores of the control class and the experimental class, which was 55 compared to 75. This study concluded that learning media for introducing Indonesian culture based on adaptive educational games had a positive impact by effectively increasing learning outcomes on students' understanding of Indonesian culture. Further development of this game application can be expanded in the application of animation in more depth.

Keywords: adaptive learning, adaptive educational, educational game, learning atmosphere, learning outcomes, innovative learning



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1. Introduction

Culture is a local area asset that must be lived and maintained properly. It is very wise not to neglect recipients of high-value cultural heritage so that the heritage is properly maintained. Culture in education is defined as the

historically transmitted patterns of meaning that include the norms, values, beliefs, ceremonies, rituals, traditions, and myths understood, perhaps in varying degrees, by members of the school community. This system of meaning often shapes what people think and

how they act" (Tolchinsky & Salas, 2018; Giorgetti et al., 2017). The role of culture in education is to provide direction for the learning environment. The environment in question is 1) the natural environment, shaped by the culture of students and teachers, and 2) the artificial environment, which is the result of interaction between teachers and students. The concept of culture in education derives from workplace culture in the industrial world, namely, situations that provide the foundation and direction for effective, efficient processes.

"Nusantara culture," the term for indigenous Indonesian culture, is part of Indonesia's long history and must be preserved. Archipelago culture includes clothing, houses, dance, weapons, and musical instruments. One of the impacts of the progress of an increasingly modern world, Indonesian culture is increasingly marginalized and forgotten. This condition is found in the majority of the younger generation, who are the nation's future. They are more familiar with Western culture than with native Indonesian culture. It is really concerning that it was found that the results of the initial survey in the field showed that only a handful of elementary school students (26%) were still familiar with the original culture of their own nation, such as the names of traditional clothing, names of dances, names of traditional houses, and names of musical instruments. This situation is a yellow light for the importance of preserving Nusantara culture.

So far, efforts to introduce and learn about the archipelago's culture have been carried out in a conventional way (generally book-based). The use of conventional methods for learning about the archipelago's culture has proven ineffective because the presentation of the material is unattractive, and there is no active interaction among learning elements, leaving students bored and

uninterested in learning (Molino et al., 2015). Based on the identified obstacles and an analysis of needs in schools, innovative learning media to develop students' interest in learning about Nusantara culture are urgently needed (Sulistyanto et al., 2022).

Much research has focused on developing effective learning media to improve students' abilities and learning outcomes in schools. One of them is media based on educational games (Sowden et al., 2015). A systematic literature review was conducted by (Moreno Ger et al., 2007) and (Takacs et al., 2015) which revealed that 43 research literature on educational games have adopted different methods to assess the effectiveness of educational games that vary in the learning and professional training domains. The results of these studies also report that 60% of research on the use of educational games has tested their effectiveness in primary or secondary school settings. These findings indicate that teachers in primary or secondary education are highly recommended to combine educational games with traditional teaching (Yilmaz et al., 2014). Through this method, a new learning strategy is implemented and has been shown to inspire students' creativity in exploratory learning experiences.

Gamification has become popular in education in recent years. Advantages include allowing students to experience learning in a multi-sensory, active, and experimental environment. Specifically, students can use these educational games for experimental learning to develop their decision-making and problem-solving skills in a dynamic learning environment (Vasileva-Stojanovska et al., 2015). In addition, students can receive immediate feedback/results for their answers, rather than delayed feedback from conventional assessment methods (e.g., tests and exams). In addition, some educational gamification can help reduce boundaries around time and place, as

portable devices allow students to study anytime, anywhere. This easy-to-use tool can make difficult subjects easier to understand and memorize (Mayer, 2014). In other words, with the use of educational games, the learning process is considered more interesting (Ben Abacha et al., 2013), motivating (Pachoulakis et al., 2012), achieving knowledge retention (Jepp et al., 2010), increasing attention (Tan et al., 2007b), and can even improve peer communication and social skills (Khenissi et al., 2015).

On the other hand, the advantages of using gamification in education do not necessarily mean it will receive widespread advocacy, as it has also produced mixed results (Miller et al., 2014). Although extensive research supports the use of educational games to help broaden students' learning experiences, it has been found that young students are more likely to be inattentive (Hwang et al., 2016; Nousiainen et al., 2018) even documented that some students did not find educational games motivating or interesting because individuals usually play games just for entertainment purposes, so the application of gamification in educational settings may not produce good motivational effects. If individuals have the choice to play educational games as fun and relaxing, then they fall into the latter category (Sulistyanto et al., 2023), so they consider educational games boring (Baek & Whitton, 2013). In addition, participating in educational games may even have detrimental effects. According to (Garber et al., 2017), the use of educational games is associated with lower academic achievement.

However, the use of educational games has greatly helped alleviate learning problems. Past research has shown that students' attitudes toward learning, class attendance, and mood are more positive than when using conventional teaching and learning methods (Hwang et al., 2016). It is believed that in the

learning process, when students have the opportunity to participate in decision-making, they will enjoy learning more because they perceive "learning" as "playing" (Alamsyaha et al., 2023). Even though children are getting older, their attention and concentration are also increasing (Manuri & Sanna, 2019), it is important to ensure that students' learning motivation remains at a high level when using game learning media (Surjono, 2011). In other words, by using educational games during learning, students will be asked to consistently focus on the content needed to successfully complete game tasks, while their motivation to learn remains high due to the inclusion of game elements in the learning process.

The real impact of gamification on learning motivation is not well understood, which certainly presents a research gap for now. An educational game that is fun, motivating, and ultimately effective for learning can depend on students' personal characteristics and learning preferences. Therefore, this research investigated the role of learning style factors in assessing the effectiveness of educational games in improving student learning outcomes.

2. Method

Research was carried out using the stages of problem identification and analysis methods, solution design, repeated testing and design refinement, and reflection to produce design principles and implementation (Seechaliao, 2017). The resulting product was an educational game learning media that was tailored to students' learning styles. In the problem identification and analysis phase, specifications for student needs were also determined. Delivery of solutions using Construct 2 tools was used to design game applications. Product draft validation was conducted by two educational game media

experts and two cultural content experts. Meanwhile, to determine the learning style, the Learning Styles Version 7 instrument was used. The feasibility test was conducted with a group of student samples obtained through cluster random sampling across several elementary schools. Testing the impact of educational game media was conducted using a

pretest-posttest control group design, as shown in Table 1. Samples were taken using cluster random sampling to determine the experimental and control classes for testing product effectiveness. The results of educational game media products are shown in Figure 1.

Table 1. Design of Application Media Product Testing

Group	Pre-Test	Treatment	Post-Test
Re	T ₁	X	T ₂
Rc	T ₃	-	T ₄

R : experimental and control groups taken by random clusters
 T₁, T₃ : pre-test
 X : treatment with product
 T₂, T₄ : post-test

(Leow & Neo, 2014)



Figure 1. Developed Application Product

Figure 1A is the display of the main menu of Archipelago Culture learning media. In this view, there are several menus, namely the "Learn" menu, which contains material about archipelago culture; the "Play" menu, which contains games that students can play; the "Information" menu, which provides interactive media information; the "Settings" menu contains sound settings; the "Info" menu contains instructions for playing/learning; and the "Power" menu is used to exit the application. Figure 1B shows the "Learning" menu, which contains several choices of archipelago culture learning

materials. There are 5 types of learning materials: clothes, houses, dances, weapons, and traditional musical instruments. Figure 1C is an initial view of the housing materials. The arrow button on the right opens the next page in the home menu; the back button returns to the study menu. This menu contains 33 pictures of houses from various provinces in Indonesia. If one of the images is clicked, a larger and clearer learning pop-up menu will appear. Figure 1D shows questions on the game menu that students must answer. If the question is answered correctly, the student gets 2 coins; if answered incorrectly, their life

is reduced. If the student does not answer the question at all, the question will not disappear and will follow the player.

The test used to assess the effectiveness of product development was the T-Test, which aimed to determine the average value (mean) of each group by first meeting the analytical prerequisites for normality, homogeneity, and balance.

The normalized gain test (N-Gain) was conducted to assess the increase in students' cognitive learning outcomes following treatment. This increase was taken from the pre-test and post-test scores obtained by students. N-Gain is a comparison of the actual gain score with the maximum gain score (Pachoulakis et al., 2012). The actual gain score is the score obtained by the student, while the maximum gain score is the highest possible score the student can obtain. Calculation of the normalized gain score (N-Gain) can be expressed in the following formula:

$$\text{Gain Score} = \frac{\text{Post Test Score}}{\text{Ideal Score} - \text{Pre Test Score}} \times 100\% \quad (1)$$

Pre-test Score: pre-test scores obtained

Post-test Score: post-test scores obtained.

Ideal Score: a maximum score that can be obtained

Category of the interpretation of the effectiveness of the gain score:

Gain score < 40 : Ineffective

$40 \leq \text{gain score} \leq 55$: Less effective

$56 \leq \text{gain score} \leq 75$: Effective enough

Gain score > 75 : Effective

(Sulistyanto et al., 2019)

3. Results and Discussion

This research produced an educational game application that adapts to students' learning styles. The application of media in

the classroom was carried out by first determining each student's learning style as visual, auditory, or kinesthetic. Furthermore, learning uses cultural introduction material as well.

Product effectiveness testing was done by dividing students into control and experimental classes. The control class used conventional learning methods (lectures). Before learning began, students were given a pre-test to assess their initial abilities. The pre-test is very important for determining the effect of the control class after being treated differently from the experimental class. After the learning process was completed, students were given post-test questions to assess differences in learning outcomes using conventional methods (lectures).

Testing the effectiveness of the media used the T-test (Kintu & Zhu, 2016). The main prerequisite before conducting a T-test is to assess the normality and homogeneity of the sample data to ensure that the effectiveness test is suitable for parametric tests. If otherwise obtained, then use a non-parametric test.

The results of the normality test for pre-test and post-test scores in both groups, namely the control and experimental groups, were presented in Table 2. Based on the results of the Kolmogorov-Smirnov normality test, the significance values for each group in the pre-test and post-test were > 0.05, indicating that the data are normally distributed.

A homogeneity test was carried out after determining the normality of the data distribution. This test aimed to determine the degree of similarity between the variances of the two classes, namely, control and experiment. The results of the homogeneity test are shown in Table 3.

Table 2. The Results of the Normality Test of the Pre-Test and Post-Test Scores

		Test of Normality					
Group		Kolmogorov-Smirnov ^a			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pretest	Experiment	.134	30	.180	.942	30	.102
	Control	.139	30	.144	.944	30	.118
Post-test	Experiment	.154	30	.067	.951	30	.183
	Control	.151	30	.080	.953	30	.198

a. Lilliefors Significance Correction

Table 3. The Results of Homogeneity T-Tests

		Levene Statistic	df1	df2	Sig.
Pretest	Based on the mean	.005	1	58	.943
	Based on Median	.193	1	98	.661
	Based on the median and with adjusted df	.193	1	97.429	.661
	Based on trimmed mean	.070	1	98	.791
Post-test	Based on the mean	4.757	1	98	.032
	Based on Median	2.443	1	98	.121
	Based on the median and with adjusted df	2.443	1	89.971	.122
	Based on trimmed mean	4.953	1	98	.028

Find out whether to accept or reject the hypothesis; this can be determined from the significance of the Levene statistic. The pre-test and post-test data in the table above showed a p -value > 0.05 , indicating homogeneous variance.

The hypothesis test aimed to determine whether there is a difference between conventional and adaptive educational game-based learning methods.

The paired-sample t -test was conducted to determine whether there was a difference in the means of the two paired samples. The requirement before conducting the paired-sample t -test was that the data must be normally distributed, as shown in Table 2. The paired-samples t -test was conducted to determine the effect of the adaptive learning media "Nusantara Culture" on students' learning outcomes.

Table 4. Paired Samples Statistics Results

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	Mean	Std. Dev	Paired Diff		t	df	Sig.(2-tailed)	
			Std. Error Mean	95% Confidence interval of the Diff				
				Lower				Upper
Pair 1 Pre-test control: Post-test control	-5.033	7.280	1.329	-7.751	-2.314	-3.787	29	.001
Pair 2 Pre-test experiment Post-test experiment	-23.333	9.400	1.716	-26.843	-19.823	-13.595	29	.000

According to Table 4, the results of the paired sample T -test show that the significant value of pair 1 (pre-test control and post-test control) and pair 2 (pre-test experiment and post-test experiment) is 0.00. The results

obtained from the two pairs showed the same significance value, namely, $0.00 < 0.05$, so it could be concluded that there was a difference in the average student learning outcomes between the pre-test control and post-test

control and between the pre-test experiment and post-test experiment. The following are the average results obtained:

Table 5. The Results of Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 pre-test control	50.133	30	11.2548	2.0548
Post-test control	55.166	30	10.0587	1.8365
Pair 2 pre-test experiment	51.833	30	10.1066	1.8452
Post-test experiment	75.166	30	10.3859	1.8962

Table 5 shows the average values for the two classes, namely control and experiment. The control class at the pre-test obtained an average of 50.13 and at the post-test, 55.16. The experimental class obtained an average of 51.83 on the pre-test and 75.16 on the post-test.

This study used an independent-samples t-test to determine whether there was a difference in the means of the two unpaired

samples. The requirements before conducting the independent T-test were that the data must be normally distributed and homogeneous. This test aimed to determine differences in student learning outcomes between the use of the adaptive learning media "Nusantara Culture" and conventional methods. The results of the independent sample T-test were obtained as follows:

Table 6. Result of Independent Sample t-Test Results

		Levene's Test for Equality of Variance		T-test for Equality of Means						
Study result		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of The Difference	
									Lower	Upper
Equal assumed	Equal as-sumed	.005	.943	7.577	58	.000	20.00000	2.63973	14.71600	25.28400
	Equal as-sumed			7.577	57.941	.000	20.00000	2.63973	14.71600	25.28400

Based on Table 6, the results of the independent-samples t-test for the post-test of the two classes showed a significant value < 0.05 , indicating a difference in average student learning outcomes between the use of

Archipelago Culture learning media and conventional learning methods. The following were the average results obtained:

Table 7. Group Statistics Results

	Groups	N	Mean	Std. Deviation	Std. error Mean
Study Results	Experiment	30	75.1667	10.3859	1.8962
	Control	30	55.1667	10.0587	1.8365

The results in Table 7 showed that the average value for the control class was 55.16 and for the experimental class, 75.16. Based on the results obtained, it can be concluded that the use of learning media for Learning Nusantara Culture is more effective than conventional methods.

The product resulting from this research was an educational game learning media for Nusantara Culture. "Nusantara Culture" learning media contained subject matter introducing clothing, houses, dances, musical instruments, and traditional weapons. This media was developed for fourth-grade elementary school students to increase their interest and learning outcomes in studying the archipelago's culture. The learning media for Nusantara Culture presented explanations of Indonesian culture, supported by images for each topic in the game concept (Pombo & Marques, 2019). The game had questions that already covered existing material for student practice. This learning media needs to be tested for its usefulness and effectiveness in line with the requirements for using learning applications (Setyaningsih et al., 2022).

Testing was conducted by media and materials experts. The feasibility test had also been carried out on a sample of student users. The material validation test yielded an average value of 0.82, with 10 items declared valid. Cronbach's alpha was 0.78, indicating strong reliability, and each item had an interpretation percentage of 67%, indicating the item is suitable for use as an instrument.

Meanwhile, the media expert test was conducted by lecturers at Muhammadiyah University of Surakarta, with an average score of 0.76 across 10 items, which was deemed valid. Cronbach's alpha was 0.769, indicating perfect reliability, and each item had an interpretation percentage above 56%, indicating that the items are suitable for reuse as an instrument. The results of the questionnaire

assessment, completed by 30 students, yielded an average SUS score of 80.6, which falls within the Acceptable category, indicating that this learning media was acceptable to students.

Some of the latest research findings, as in, (Kurniawan et al., 2022; Sidiq et al., 2021) clarify that the application of validation tests and due diligence is a crucial part of developing learning media. Many research studies reported very good effectiveness of educational game-based learning media in carrying out the learning process compared to conventional models.

The effectiveness of educational game-based learning media has been tested across several categories of test variables, as has been done by (Akbar, 2009; Kovačević & Opić, 2014; Hamizul & Rahimi, 2015; Sepehr & Head, 2018). This research examined the role of student learning style variables in improving learning outcomes. This study examined whether there was a difference in student learning outcomes in Indonesian Culture material between educational game learning media and conventional methods (lectures). Based on empirical studies, there are several reasons to use educational game-based learning media that can positively impact student interest and learning outcomes. For example, (Tan et al., 2007a; Paiboonsithiwong et al., 2016) said that game-based learning media could create a fun, relaxed learning atmosphere.

Game media provide understanding, memory, concentration, interaction, and a more interesting learning environment compared to traditional learning environments (Cheung & Ng, 2021). Furthermore, this research indicates that the use of game-based media can increase concentration and understanding by Vandercruysse (2021). In other studies, educational game applications also make it easier and faster for teachers to help

students understand the learning process (Bang & Flynn, 2023)

This study used two classes: the control and the experimental. Before receiving treatment in the control and experimental classes, they took a quiz to determine learning styles and a pre-test to assess students' prior knowledge. After being given a pre-test, the two classes were given different treatments in learning methods: the experimental class used Nusantara Culture learning media, while the control class used conventional methods (lectures). Furthermore, the control and experimental classes were given post-test questions to determine whether there were differences in student learning outcomes after treatment. Based on the research results obtained, it showed that the use of educational game learning media could improve student learning outcomes

The results of the paired-sample T-test showed a significant value of $0.00 < 0.05$, indicating a difference in average student learning outcomes between the pre-test experiment and the post-test experiment and between the pre-test control and the post-test control. The results also showed that the difference between the pre-test and post-test values for the experimental class was higher than that for the control class, namely 24 for the experimental class and 5 for the control class. The results of the independent-samples t-test also showed a significant p-value of $0.000 < 0.005$, indicating a significant difference between the average values of the experimental and control classes. The results of this research strengthened the findings from studies by (Novia et al., 2020; EROĞLU, 2020; Al-Tarawneh, 2016) which state that students' understanding can be increased by providing tools for learning that follow natural learning styles according to student needs.

Based on the results of data testing and analysis, the researchers concluded that

educational game-based adaptive learning media can improve student learning outcomes and are quite effective in increasing understanding of Indonesian culture compared to conventional methods (lectures).

4. Conclusion

Several conclusions could be drawn from the results of this study. The product developed from this research was an adaptive learning media based on educational games on Indonesian cultural material for grade IV elementary school students. The learning media was developed using Construct 2 software. The research results from questionnaire calculations obtained from media experts, subject matter experts, and students showed that the average coefficient V for media experts was 0.76, which was declared valid, and the reliability test yielded a value of 0.769, indicating strong reliability. The average coefficient V from material experts was 0.82, which was deemed valid, and the reliability test was 0.781, indicating strong reliability. The average SUS score on the student questionnaire was 80.67, which fell within the sufficient category. Media products increase students' interest and learning outcomes in studying the archipelago's culture, as evidenced by the increase in pre- and post-test scores of the experimental class. The results of the independent-samples t-test showed a difference in average student learning outcomes between students using adaptive educative game learning media and those using conventional media. The average student learning outcomes in the control class were 50 for the pre-test and 55 for the post-test. The experimental class had 51 for the pre-test and 75 for the post-test. The findings of this study recommend that teachers use educational game-based learning media to increase student interest and learning outcomes.

5. Authors Contribution

Hernawan

Sulistiyanto:

Conceptualization, Methodology, Software, Investigation, Data Curation, Formal Analysis, Writing – Original Draft; **Djumadi:** Methodology, Validation, Writing – Review & Editing; **Bambang Sumardjoko:** Methodology, Validation, Writing – Review & Editing; **Muhammad Izzul Haq:** Formal Analysis, Writing – Review & Editing; **Gamal Abdul Nasir Zakaria:** Formal Analysis, Writing – Review & Editing; **Sabar Narimo:** Formal Analysis, Writing – Review & Editing; **Dyah Astuti:** Formal Analysis, Writing – Review & Editing; **Muhammad Syahriandi Adhantoro:** Formal Analysis, Writing – Review & Editing; **Devary Pradana Setyabudi:** Formal Analysis, Writing – Review & Editing; **Yasir Sidiq:** Formal Analysis, Writing – Review & Editing; **Naufal Ishartono:** Formal Analysis, Writing – Review & Editing.

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