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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 taken 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 is 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 to not let recipients of high-value cultural heritage be neglected so that the heritage is not 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 an attempt to provide direction regarding the learning environment. The environment in question is: 1) The environment is natural and by the culture of students and teachers; 2) Artificial environment which is the result of interaction between teachers and students. The concept of culture in the world of education comes from workplace culture in the industrial world, namely situations that provide the foundation and direction for an effective and efficient process to take place.

Nusantara culture, the name for indigenous Indonesian culture, is part of the long history of the Indonesian nation which must be maintained and 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 as the successor to the survival of the nation. They are more familiar with the culture adopted from the Western world than the native Indonesian local 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 culture of the archipelago have been carried out in a conventional way (generally book-based). The use of conventional methods in learning the culture of the archipelago has proven to be ineffective because the way the material is presented is unattractive and there is no active interaction between learning elements so it makes students bored and not interested in learning (Molino et al., 2015). Based on the obstacles found and an analysis of needs in schools, an innovative learning media that can develop students' interest in learning the Nusantara culture is urgently needed (Sulistyanto et al., 2022).

Much research has been done on the development of 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 specifically that 60% of the research on the use of educational games has been tested for their effectiveness in the educational environment of primary or secondary schools. 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 proven 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.,

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2015). In addition, students can receive immediate feedback/results for answers, rather than receiving delayed feedback from conventional assessment methods (eg tests and exams). In addition, some educational gamification can help reduce boundaries, including time and place, because portable devices allow students to study and/or study anytime and 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 even can 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 that it will receive extraordinary advocacy, as it has also produced several 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 educa-

tional games is associated with a decrease in academic achievement.

However, the use of educational games has helped a lot to alleviate learning problems. Past research has shown that students' attitudes toward learning, class attendance, and mood are more positive when compared to 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 always focus on teaching content to successfully complete tasks in games, while their learning motivation remains high due to the inclusion of game elements in the learning process.

The real impact of gamification on learning motivation is not clearly known, which certainly provides a research gap for now. An educational game that is fun, motivating, and ultimately effective for learning can depend on the personal characteristics and learning preferences of students. Therefore, this research investigated the involvement of learning style factors in assessing the effectiveness of educational games to improve student learning outcomes.

2. Method

Research was carried out with the stages of problem identification and analysis methods, solution design, repeated testing and design refinement, as well as reflection to produce design principles and implementa-

tion (Seechaliao, 2017). The resulting product was an educational game learning media that was applied to student learning styles. In the problem identification and analysis phase, specifications for student needs were also determined. Delivery of solutions using the help of Construct 2 tools was conducted to design game applications. Product draft validation was carried out by two educational game media experts and cultural content experts. Meanwhile, to determine the type of learning style, the instrument for determining learning styles version 7 was used. The fea-

sibility test was attempted on a group of student samples taken using the cluster random sampling technique in several elementary schools. Testing the impact of using educational game media was carried out using the pretest-posttest control group design as shown in Table 1. Samples were taken using cluster random sampling to determine the experimental class and control class to be used in 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
T_1, T_3 : pre-test
X   : treatment with product
T_2, T_4 : 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 contains games that students can play, the "Information" menu provides interactive media information, the "Settings" menu contains sound settings, the "Info" menu

contains Instructions" contains instructions for playing/learning, and the "Power" menu is used to exit the application. Figure 1B is a display of the "Learning" menu containing several choices of archipelago culture learning materials. There are 5 choices of learning materials, namely clothes, houses, dances, weapons, and traditional musical instruments. Figure 1C is an initial view of

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the housing materials. The arrow button to the right is used to open the next page on the home menu, the back button is used to return to the study menu. On this menu, there are 33 pictures of houses from various provinces in Indonesia. If one of the images is clicked, a larger and clearer learning popup menu will appear. Figure 1D is a display of questions on the game menu where students must answer existing questions. If the question is answered correctly the student gets 2 coins, but if the student answers the question incorrectly then his life will be reduced. Whereas if the student does not answer the question at all then the question will not disappear and follow the player.

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

The normalized gain test (N-Gain) was carried out to determine the increase in students' cognitive learning outcomes after being given 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 gain score obtained by the student, while the maximum gain score is the highest possible gain score that the student can obtain. Calculation of the normalized gain score (N-Gain) can be expressed in the following formula:

$$Gain\ score = \frac{Post\ Test\ score}{Ideal\ score - Pre\ Test\ score} x100\% \quad (1)$$

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
$40 \leq$ gain score ≤ 55 : Less effective
$56 \leq$ gain score ≤ 75 : Effective enough
Gain score > 75 : Effective
(Sulistyanto et al., 2019)

3. Results and Discussion

This research produced educational game application that adapt to students' learning styles. The application of media in the classroom was carried out by first determining the learning style of each student in the visual, auditory, or kinesthetic category. Furthermore, learning uses cultural introduction material as well.

Product effectiveness testing was done by dividing students into control and experimental classes. In the control class using conventional learning methods (lectures). Before learning began, students were given a pre-test beforehand to find out the students' initial abilities. The pre-test is very important to do to determine the effect of the control class after being treated differently from the experimental class. After the learning process was carried out, students were given post-test questions to see 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 carrying out testing with the T-test is to determine the normality and homogeneity of sample data to ensure that the effectiveness test is suitable through parametric tests. If otherwise obtained, then through a non-parametric test.

The results of the analysis of the normality test of 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 analysis of the data normal-

ity test using Kolmogorov Smirnov, the significance results of each group in the pre-test and post-test had a value of >0,05 so it can be concluded that the data distribution is normally distributed.

A homogeneity test was carried out after knowing the level of normality of the distribution of data. This test aimed to determine the level of similarity of the variants between the two classes, namely, control and experiment, the results of the homogeneity test were obtained as Table 3.

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

Group		Test of Normality					
		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Pre test	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 Tes

		Levene Statistic	df1	df2	Sig.
Pre test	Based on Mean	.005	1	58	.943
	Based on Median	.193	1	98	.661
	Based on Median and with adjusted df	.193	1	97.429	.661
	Based on trimmed mean	.070	1	98	.791
Post test	Based on Mean	4.757	1	98	.032
	Based on Median	2.443	1	98	.121
	Based on 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, it can be seen from the significant value on the Levene statistic. The pre-test and post-test data in the table above showed a sig value > 0,05, so it is said to have a homogeneous variant.

The hypothesis test aimed to determine the difference between conventional and adaptive educational game-based learning methods.

The paired sample T-test was conducted to find out whether there was a difference in the mean 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 sample T-test was conducted to determine the effect of the adaptive learning media "Nusantara Culture" on student learning outcomes.

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Table 4. Paired Samples Statistics Results

	Mean	Std. Dev	Paired Diff Std. Error Mean	95% Confidence interval of the Diff Lower	95% Confidence interval of the Diff Upper	t	df	Sig.(2-tailed)
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 the Table 4, the results of the paired sample T-test show that the significant value of pair 1 (pre-test control and posttest 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 for pretest control with post-test control and pre-test experiment with 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 is the average value of the two classes, namely control and experiment. The control class at the pre-test obtained an average value of 50,13 and a post-test of 55,16. While the experimental class at the pretest obtained an average value of 51,83 and a posttest of 75,16.

This study used an independent sample T-test to determine whether there was a difference in the mean 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 using the adaptive learning media "Nusantara Culture" with 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 F	Levene's Test for Equality of Variance Sig.	T-test for Equality of Means t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of The Difference Lower	95% Confidence Interval of The Difference Upper
Study result	Equal assumed	.005	.943	7.577	58	.000	20.00000	2.63973	14.71600	25.28400
	Equal assumed			7.577	57.941	.000	20.00000	2.63973	14.71600	25.28400

Based on the Table 6 the results of the independent Sample t-Test for the post-test of the two classes showed a significant value <0,05, meaning that there is a difference in the average student learning outcomes be-tween the use of learning media learning media Archipelago Culture 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 of the Table 7 showed that the average value obtained by the control class was 55,16 and the experimental class was 75,16. From the results obtained, it can be concluded that the use of learning media for Learning Nusantara Culture is more effective than using 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 student interest and learning outcomes in studying the culture of the archipelago. The learning media for Nusantara Culture presented material explanations about culture in Indonesia with the support of images for each material in the game concept. The game had questions that already cover existing material for student practice. This learning media needs to be tested for its usefulness and effectiveness by the requirements for using learning applications (Setyaningsih et al., 2022).

Testing had been carried out by media and material experts. The feasibility test had also been carried out on a sample of user students. The results of the material validation test obtained an average value of 0,82 with 10 question items declared valid, Croncbach's alpha was 0.78 which means strong reliability with each item obtaining an interpretation percentage of 67%, which means the item is suitable for use as an instrument.

Meanwhile, the results of the media expert test were carried out by lecturers at the Muhammadiyah University of Surakarta by obtaining an average value of 0,76 out of 10 items which were declared valid. Cronbach's alpha was 0,769 which means perfect reliability and each item obtained an interpretation percentage above 56%, which means that the item is fit to be reused as an instrument. The results of the questionnaire assessment which were filled in by 30 students obtained an average SUS score of 80,6 included in the Acceptable category, meaning 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 very crucial part of developing a learning media. The results of many research studies reported very good effectiveness in educational game-based learning media to carry out the learning process compared to conventional models.

The effectiveness of educational game-based learning media had been tested on several different category 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 compared whether there was a difference between student learning outcomes in Indonesian Culture material using educational game learning media with conventional methods (lectures). Based on empirical studies, there are several reasons for the use of educational game-based learning media that can have a positive impact on student interest and learning outcomes. For example, (Tan et al., 2007a; Paiboonsithiwong et al., 2016) said that game-based learning media could present a fun and relaxed learning atmosphere.

Understanding, memory, concentration, interaction, and a more interesting learning environment are provided by game media compared to traditional learning environments (Cheung & Ng, 2021). Furthermore, the use of game-based media as a result of this research can increase concentration and understanding as in (Vandercruysse, 2021). In other studies, educational game applications also make it easier and faster for teachers to provide students with an understanding of the learning process (Eva Handriyantini, 2009).

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

It was evident from the results of the paired sample T-test obtained that it showed a significant value of 0.00 <0.05, so it can be concluded that there is a difference in the average student learning outcomes for the pre-test experiment with the post-test experiment and also the pre-test control with post-test control. The results also showed that the difference between the pre-test and post-test values of the experimental class was higher than the difference in the pre-test and post-test values of the control class, namely 24 for the experimental class and 5 for the control class. The results of the independent sample T-test also showed a significant value of 0.000 <0.005, meaning that there was a significant difference between the average value of the experimental class and the control class. 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 learning that follows natural learning styles according to student needs.

Based on the results of data testing carried out and the results of data analysis obtained, 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 culture material for grade IV elementary schools. Learning media was developed using Construct 2 software. The research results of questionnaire calculations obtained from media experts, subject matter experts, and students showed that the average coefficient V from media experts was 0.76 which was declared valid, and the reliability test obtained a range of 0,769 which stated had strong reliability. The average result of the coefficient V from material experts is 0,82 which was declared valid and the reliability test is 0,781 which indicates strong reliability. The average SUS score in the student questionnaire was 80,67, which was included in the sufficient category. Media products increase students' interest and learning outcomes in studying the culture of the archipelago as evidenced by the increase in the pre-test and post-test scores of the experimental class. The results of the Independent Sample T-test showed that there was a difference in the average score of student learning outcomes between those 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. While the experimental class numbered 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.

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