Indonesian Society for Science Educators

Journal of Science Learning

journal homepage: ejournal.upi.edu/index.php/jslearning

The Effect of Mobile Learning Integrated Traditional Games *Egrang* to Improve Multiple Representation Skills

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ABSTRACT Integrating traditional games into science learning can reconstruct local knowledge into scientific knowledge. One of the most popular technologies today is the mobile phone, which almost everyone uses. This study investigates the effect of mobile learning integrated with traditional games Egrang on students' multiple representation skills. This study used a quasi-experimental design of 64 7th junior high school students randomly assigned to experimental and control groups who learn motion and force concepts. Learning activities in the experimental class used mobile learning, while the control class used textbooks. The experimental class with ($t = 8.78$, $p < .05$) and N-gain score 0.20. Besides, the control class with ($t = 3.87$, $p < .05$) and N-gain score of 0.09. The study results found that students in the experimental class scored more in multiple representation skills than in the control class. Mobile learning integrated traditional games Egrang improves students' multiple representation skills, especially pictorial and mathematical representation. The results of this study can be used as a reference for integrating technology and indigenous knowledge into another science concept.

Keywords Mobile learning, Multiple representations, Science, Traditional game

1. INTRODUCTION

Science is considered to be difficult by many students in junior high school, especially in physics concepts. Students view physics as conceptually complicated and abstract (Morales, 2017). Learning physics must bring students into real-life situations, and students will find physics concepts more relevant. According to previous studies, students' experience relating to concrete, real-life examples in physics concepts may create meaningful learning (Baran, Maskan, & Yasar, 2018). Creating fun learning activities that allow students to experience physics concept examples related to the environment surrounding them is feasible for attracting students' interest in learning physics (Hochberg, Kuhn, & Müller, 2018).

Local culture can be brought into the science classroom to build a learning environment that relates to students' daily lives, making the learning process meaningful. Integrating local culture into school curricula has an advantage in perceiving national identity for students (Liliarti & Kuswanto, 2018). Indonesia is a big country that consists of a lot of ethnic groups. In Indonesia, various local cultures have potencies to be integrated into science learning. In a previous study, traditional toys and games were also been used to engage Indonesian students in analytical and critical thinking during the discussion about mechanics (Maghfiroh & Kuswanto, 2022; Permata Sari, Nikmah, Kuswanto, & Wardani, 2020).

The younger generation has marginalized many traditional games and prefers to play games on smartphones. The tremendous development of technology has influenced all aspects of life, including education. The function of technology has evolved a lot. One of the most popular technologies today is the mobile phone, which almost everyone uses (Crompton & Burke, 2020). Currently, the primary function of mobile phones is not only as a communication tool but also as a learning media in the classroom, known as "mobile learning" (Rahmat, Kuswanto, & Wilujeng, 2023). Technology can help students understand situations and problems in the real

Received: 25 May 2023
Revised: 28 September 2023
Published: 04 December 2023

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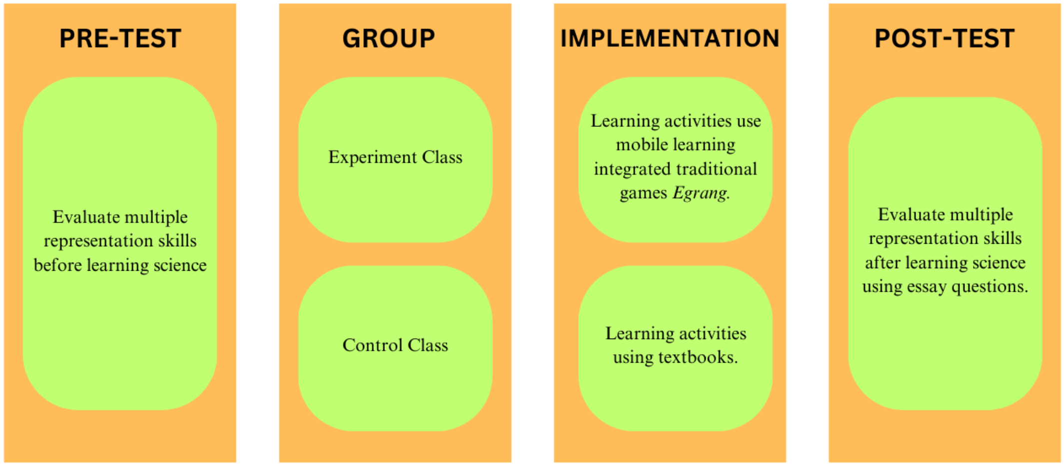


Figure 1. The research design of this study

world by visualizing the materials (Kiryakova, Angelova, & Yordanova, 2018). Integrating today's popular mobile learning with traditional games can potentially preserve culture and introduce these traditional games to the young generation.

Based on previous research, it was found that traditional games have been successfully integrated into science education. In the western part of Java island in Indonesia, the influence of Sundanese culture is dominant. Several traditional games from Sundanese culture have been integrated, namely Engklek (Rizki, Suprapto, & Admoko, 2022; Sari, Nikmah, Kuswanto, & Wardani, 2019), Kelereng (Damayanti & Kuswanto, 2021; Utari & Prima, 2019), Kolecer (Sholahuddin & Admoko, 2021), and Congklak (Nurdiana & Widodo, 2019). The Sundanese culture can be seen through traditional games called 'Egrang', which most middle school students are familiar with because they are usually found on Indonesia Independence Day but are now rarely found. Egrang is played using a pair of bamboo, then made a pedestal as footwear and must be able to maintain balance. The application of motion and force concepts can be seen directly in the traditional game Egrang (Putranta, Kuswanto, Hajaroh, & Dwiningrum, 2022).

With the significant growth of advanced technology in this era, students need to be able to interpret a problem in daily life quickly. Using and selecting the appropriate representation format in science learning can improve learning achievements (Bernacki, Greene, & Crompton, 2020; Klimova, 2019), provide access to more detailed knowledge (Sutriani & Mansyur, 2021), and make it easier to understand science concepts (Biswas, Roy, & Roy, 2020).

The multiple representations in science learning are a characteristic of science itself, which is descriptive, procedural, and declarative (Opfermann, Schmeck, & Fischer, 2017). The descriptive characteristics of science describe the science concepts using verbal representations. The procedural can be interpreted as students doing something according to the stages contained in the procedure and usually using pictorial representations to facilitate understanding of the concept. Meanwhile, declarative characteristics are related to proving phenomena and using mathematical modeling to describe phenomena and relationships between variables in physics. Representations commonly used in science learning are pictures, graphs, diagrams, and mathematical and verbal representations (Kurniawan & Kuswanto, 2021; Rahayu & Kuswanto, 2021).

Integrating mobile learning and traditional games can be combined in the physics classroom to engage students in learning physics (Maghfiroh & Kuswanto, 2022). This study identifies the effect of mobile learning integrating traditional games like Egrang into a physics learning activity. Students use smartphones to play traditional games like Egrang and analyze the concepts while learning the concepts of motion and force. This study investigates the effect of mobile learning integrated with traditional games Egrang on students' multiple representation skills.

2. METHOD

2.1 Research Design

This study was based on a quasi-experimental design, a quantitative research method. The pre-and post-test design was used in the study. Pre- and post-tests were administered before and after students were exposed to the science learning activity. This design has two groups: experimental and control class. Both classes took "motion and force" courses in junior high school. The experimental class used mobile learning, and the control class learned to use textbooks. The multiple representation tests were evaluated in the experimental and control classes. The design research of this study is shown in Figure 1.

2.2 Participants

The research was conducted in a state junior high school in West Java, Indonesia. The participants of this study were 64 7th-grade junior high school students studying motion and force in the 2022-2023 academic year.

Table 1 Demographic characteristics of research participants

Group	Girl	Boy	Total
Experiment	17	15	32
Control	18	14	30

The research participant was selected by random cluster sampling. The demographic characteristics of student distribution regarding gender are given in Table 1. Based on information from the science teacher, integrating a traditional game into science learning was the first time at this school. It will become the first experience for teachers and students.

2.3 Design of mobile learning

Firstly, the "motion and force" topic was chosen because of its potential to attract students' attention, draw their interest, and relate to the application of the traditional game *Egrang*. The traditional game *Egrang* was chosen because it can visualize motion and force in the smartphone through mini-games. The mobile learning developed is named '*MOLERAVA*' (an acronym for mobile learning integrated Egrang in West Java), and the mobile learning design is shown in Figure 2.

In the developed mobile learning, there is also a mini-game to play the traditional game *Egrang* virtually using a smartphone. In the game, students are asked to solve problems related to the concept of physics in the traditional game *Egrang*. The concept contained in *Egrang*, and the design of a mini-game in mobile learning is shown in Figure 3.

2.4 Data Collection Instrument

The instruments used in this research are pre-test and post-test to investigate how mobile learning integrated with traditional games *Egrang* affects students' multiple representation skills. The instrument consists of five essays. Each question has a maximum score of 4. Then, the total score is multiplied by five to get the final score with a maximum score of 100. Two lectures and three practitioners as experts have validated the instrument. Question indicators in this study are shown in Table 2.

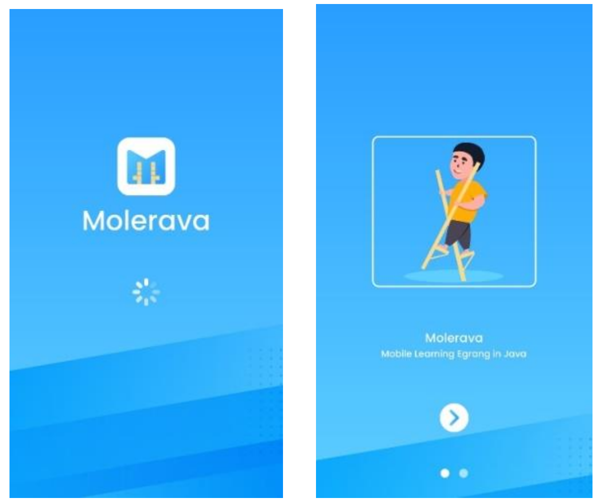
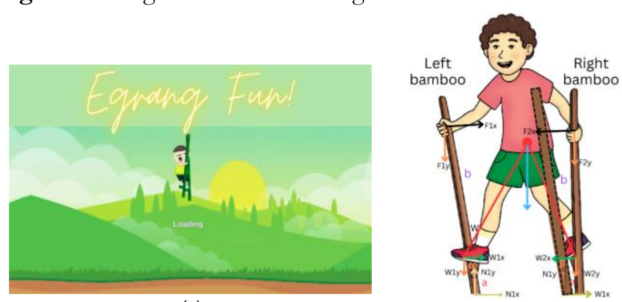


Figure 2 Design of mobile learning



(a) (b)

Figure 3 Mobile learning (a) design of mini-game; (b) concept of science in *Egrang*

2.5 Data Analysis

The research data were obtained from the pre-test conducted before the learning activities and the post-test results of the students after the learning activities. Descriptive and predictive analyses were conducted in this study. The data has been observed to follow a normal distribution, as indicated by a Shapiro-Wilk test p-value less than 0.05. A paired samples t-test was used to determine group differences. The software used for data analysis is Microsoft Excel and Statistical Program for Social Science (SPSS). Also, describe the comparison between the pre-and post-test, using the normalized gain $\langle g \rangle$. The formula for

Table 2 Detail of instrument research

Code	Skills	Aspect	Question indicator
Q1	Pictorial and verbal representation	Presents a new pattern from other representation	Students can create new patterns from the information in a picture regarding the traditional game Egrang.
Q2	Graphic and Mathematical Representation	Interpreting graphs to solve problems by involving mathematical representation	Students are asked to identify the relationship of force with mass and speed related to the traditional game Egrang.
Q3	Mathematical and Graphic Representation	Correcting the collection of information from a graph	Students are required to gather the required information from the graph feature
Q4	Graphic and Verbal Representation	Determining the meaning of a graph	Students can translate the meaning in the graphics related to the strategy of playing traditional games, Egrang.
Q5	Mathematical and Verbal Representations (Q5)	Communicating mathematical equations using multiple representations	Students can communicate mathematical information with verbal representations on problems related to how to play traditional games, Egrang

calculating the normalized gain is presented in (1), and the criteria for the normalized gain score are presented in Table 3.

$$\langle g \rangle = \frac{\%post - \%pre}{max.score - \%pre} \quad (1)$$

%post is the percentage post-test score, and %pre is the percentage pre-test score.

3. RESULT AND DISCUSSION

Mobile learning integrated traditional games Egrang was developed and named MOLERAVA (See Figure 2). Mobile learning was implemented in the experimental class and is an exciting topic for students. However, traditional games were not integrated into the control class. Learning activities in the control class used a textbook with the same topic as the experimental class. The instructional design for the experimental and control class is shown in Figure 1. Students in the experimental class have scored higher on multiple representation skills than those in the control class. This difference can be interpreted as evidence of the positive effects of using mobile learning integrated with traditional games Egrang. Previous research found that integrating traditional games into science curricula positively impacts learning (Handayani, Wilujeng, & Prasetyo, 2018; Putranta et al., 2022).

Integrating traditional games into science learning gives students experiences embodied in real life and creates meaningful learning (Saidin, Halim, & Yahaya, 2015). Learning activities related to students' daily lives, like traditional games in their area of residence, can help construct local knowledge into scientific knowledge (Rahmi & Rosdiana, 2018). Integrating traditional games Egrang in West Java in this study is a new idea to preserve culture and create meaningful learning. Integrating technology and traditional games into physics learning positively impacts student achievements (Rahayu & Kuswanto, 2021; Sari et al., 2019; Toharudin, Kurniawan, & Fisher, 2021). The students' multiple representation skills were determined within the study's aim. Detailed information on students' multiple representation skills of those in experiment and control classes can be found in Table 4.

The results show increased scores on the pre-test and post-test, as shown in Table 4. These results can be interpreted as improving students' multiple representation skills in the experimental and control classes. The significant difference between experimental and control classes shows that mobile learning scores higher in multiple representation skills than using textbooks. The experimental class with (t = 8.78, p < .05) and the control class with (t = 3.87, p < .05). The results can be interpreted that the experimental class has a significant improvement compared to the control class. This improvement is also relevant to the calculation of normalized gain (N-gain), with the experimental class having a normalized gain score of 0.22 while the control class had a score of 0.09. These findings indicate that science learning using mobile learning integrated with the traditional game Egrang demonstrates a positive impact compared to learning activities using textbooks. These results are relevant to research that mobile learning positively impacts learning achievement compared to traditional methods such as textbooks and improves multiple representation skills (Haroky, Amirta, Handayani, Kuswanto, & Wardani, 2020; Kurniawan & Kuswanto, 2021; Ramadhan, Ratnaningtyas, Kuswanto, & Wardani, 2019; Raras & Kuswanto, 2019). Each question's

Table 3 Criteria of normalized gain score

Normalized Gain ⟨g⟩	Criteria
⟨g⟩ ≥ 0.7	High
0.7 > ⟨g⟩ ≥ 0.3	Medium
⟨g⟩ < 0.3	Low

Table 4 Multiple representations of students in the experiment and control group

Group	Data	N	Mean	SD	t	p	N-gain
Experiment	Pre-test	32	39.06	6.016	8.78	0.000	0.22
	Post-test	32	52.97	6.332			
Control	Pre-test	32	38.28	6.171	3.87	0.001	0.09
	Post-test	32	43.91	7.801			

Table 5 Analysis of each item in the experimental class

Code	Skills	Data	N	Mean	SD	t	p	N-gain
Q1	Pictorial and verbal representation	Pre-test	32	7.81	2.520	3.95	0.000	0.20
		Post-test	32	10.16	2.689			
Q2	Graphic and Mathematical Representation	Pre-test	32	7.81	2.520	3.71	0.001	0.20
		Post-test	32	10.31	3.095			
Q3	Mathematical and Graphic Representation	Pre-test	32	7.81	3.345	4.98	0.000	0.28
		Post-test	32	11.25	3.111			
Q4	Graphic and Verbal Representation	Pre-test	32	7.34	2.835	4.71	0.000	0.25
		Post-test	32	10.63	2.768			
Q5	Mathematical and Verbal Representations	Pre-test	32	8.28	6.016	3.48	0.002	0.20
		Post-test	32	10.63	2.768			

Table 6 Analysis of each question in the control class

Code	Skills	Data	N	Mean	SD	T	p	N-gain
Q1	Pictorial and verbal representation	Pre-test	32	7.50	2.840	0.00	1.000	0.00
		Post-test	32	7.50	2.540			
Q2	Graphic and Mathematical Representation	Pre-test	32	8.44	2.675	0.17	0.861	0.01
		Post-test	32	8.28	3.726			
Q3	Mathematical and Graphic Representation	Pre-test	32	7.19	3.095	2.34	0.025	0.15
		Post-test	32	9.22	4.233			
Q4	Graphic and Verbal Representation	Pre-test	32	7.19	2.520	2.61	0.014	0.18
		Post-test	32	9.53	4.813			
Q5	Mathematical and Verbal Representation	Pre-test	32	7.97	2.495	3.48	0.002	0.11
		Post-test	32	9.37	2.106			

results were analyzed in each class to analyze further related to students' multiple-representation skills. The analysis of each item in the class experiment is shown in Table 5.

In the experimental class, the results of each question show the same results and do not have very significant differences. Based on the calculation of N-gain, the score for Q1, Q2, and Q5 is the same, as indicated in Table 4. The highest increase occurred in Q3, referring to mathematical and graphical representation with ($t = 4.98$, $p < .05$). These results are also relevant to the N-gain calculation, where Q3 has the highest score (with N-gain = 0.28) compared to the other question items. These results indicate that students in the experimental class can collect and represent information from a graph in a mathematical equation. On the other hand, the experimental class has a low score in Q5, which refers to mathematical and verbal representations with ($t = 3.48$, $p < .05$) and a normalized gain score of 0.20. The result indicates that students have difficulty representing mathematical equations in verbal form. Students have difficulty representing mathematical equations verbally because they consider mathematics to be related to calculations that are complex and difficult to understand (Novitasari, Usodo, & Fitriana, 2021). Students usually only memorize formulas and do not understand the interpretation of the physics concept of the formula, so they are challenged to represent it verbally (Rahmawati, Hidayanto, & Anwar, 2017). The analysis of each item in the control group is shown in Table 6.

The results of each question in the control class had different patterns, and it was found that 1 question did not change in Q1, referring to pictorial and verbal representation. These results indicate that students have difficulty interpreting the information in a picture and turning it into a pattern following the relevant concept. The highest increase occurred in Q4, referring to graphical and verbal representation with ($t = 3.48$, $p < .05$) and a normalized gain score of 0.20. These results indicate that students in the class control have difficulty understanding the meaning of a graph because students usually get data information from text. It can also be interpreted that students do not understand the concept of physics in detail, so it is not easy to interpret the graph (Hidayatulloh, Kuswanto, Santoso, Susilowati, & Hidayatullah, 2021).

The results of this study indicate that the experimental class has shown a significant improvement compared to the control class (See Table 4). In the experimental class, learning through mobile learning has shown a positive impact on improving multi-representation skills. Nowadays, students often use mobile phones in their daily activities to attract students' attention. The transformation of the function of a smartphone into a learning medium can create learning anywhere and anytime (Rahmat et al., 2023). The use of mobile learning, which can be accessed on each student's smartphone, allows them to review the learning material they have studied at home and deepen their understanding of topics that may not have been fully comprehended in school (Criollo-C, Guerrero-Arias, Jaramillo-Alcázar, & Luján-Mora, 2021; Hashimova, Prasolov, Burlakov, & Semenova, 2020).

The mobile learning developed in this study incorporates mini-games for the traditional game *Egrang* (See Figure 3). Mini-games aim to provide students with a real-life experience of playing *Egrang*. Learning based on students' experiences can foster meaningful learning (Satriawan et al., 2020). The students' virtual experiences of playing *Egrang* can serve as a new experience that can be reconstructed into scientific knowledge (Triyanto & Handayani, 2020). Presenting mini-games in mobile learning can attract students' attention (Su & Cheng, 2015). Implementing mobile learning in physics concepts can provide visuals to facilitate various representations in science learning, such as text, videos, and images. Based on previous research, it was found that the three representations presented during the use of mobile learning can help improve multi-representation skills (Kurniawan & Kuswanto, 2021; Raras & Kuswanto, 2019).

Integrating current trending technology with local culture, like traditional games that are almost extinct, is one of the ideas for preserving culture to exist today with significant technological improvements. One effective way to preserve culture in education is by integrating indigenous knowledge into the curriculum (Handayani et al., 2018). This study has undertaken to integrate traditional games from West Java, namely "Egrang," into science learning. The limitation of this study is the use of traditional games that students only know from the area, so if they are to be widely implemented, it is necessary to describe how to play the games first. Future research can integrate other local knowledge adapted to the area or science concept to be taught.

4. CONCLUSION

Integrating traditional games with mobile learning into science creates meaningful learning. Mobile learning-integrated traditional games *Egrang* from West Java was developed and implemented into science learning. It was found that there was a significant difference in students' multiple representation skills using mobile learning-integrated traditional games *Egrang* than learning using textbooks. In addition, it was found that students had difficulty representing information in other representations, such as graphical and pictorial representations.

ACKNOWLEDGMENT

The authors would like to thank the Indonesian Ministry of Education, Culture, Research and Technology for funding this study through a PMDSU (*Pendidikan Magister Menuju Doktoral untuk Sarjana Unggul*) scheme with grant number T/6.3.3/UN34.9/PT.01.03/2023.

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