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The Development of Mathematics Mobile Learning Media to Improve Students' Autonomous and Learning Outcomes

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Abstract

This study aims to (1) develop mobile learning as mathematics learning media; (2) test the practicality of the developed mathematics mobile learning media; and (3) test the effectiveness of mathematics mobile learning media that is developed towards the autonomous and learning outcomes of elementary school students. This type of research is research and development by adapting the ADDIE model. Product assessment is carried out by media experts, material experts, information technology experts, peer reviewers and trial. The research data was collected through a media assessment questionnaire and tests, then analysed with N-Gain and t-test. The results of this study are: (1) mathematics mobile learning media has been well structured by getting input from media expert validators, material experts, information technology experts, peer reviewers and students; (2) mathematics mobile learning media is considered feasible to be used in learning, in terms of material aspects, media aspects and students' test results, and (3) there is a significant increase between the autonomous and learning outcomes of students who take learning using mathematics mobile learning media with conventional learning. The results of this study indicate that the mathematics mobile learning media is feasible and effective to be used in elementary mathematics learning.

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INTRODUCTION

Education is something that is always inherent with human life. Education is a form of human culture that is dynamic and full of development. Challenges in the developing world lead to a better life. Through the process of education, humans are prepared to be able to face the challenges of the world. Like the ideals that the Indonesian wants to achieve as set forth in the Law of the Republic of Indonesia Number 20 of 2003 regarding the National Education System is that the function of education is to develop the ability and shape of dignified national character and civilization in order to educate the lives of the nation, aims to develop the potential of students to become faithful human beings, and fear God Almighty, noble, healthy, knowledgeable, capable, creative, independent and become a democratic and responsible citizen.

Information and communication technology is very influential on the development of education. Prawiradilaga (2012) mentions that the education and training is affected by the digital technology industry and the internet. This impact is considered positive because it encourages various parties, teachers, teachers, and students to adapt to innovation and the global era. In line with the opinion of Amirullah (2017) that teachers are required to be able to develop technological skills in making representative learning media as a media to support the learning process. Furthermore, Prawiradilaga (2012) explained that the learning process as part of the life of modern society gives opportunities for each individual to develop skills. The advancement and sophistication of digital technology applied in education facilitates and accelerates learning access, including the delivery of teaching materials to be faster, easier, and more affordable. Technology used as an interesting and innovative learning media is believed to be able to keep up with the times. Sakat, et al. (2012) stated that learning using technology media has a significant influence. Nowadays, digital technology is very close to students' lives. Digital technology is also potential to be developed in supporting the teaching and learning process, one of which is through mobile learning. The use of mobile learning in the classroom can cover the limited face-to-face time that teachers have with students. According to Sadiman as quoted by Lubis (2015) that mobile learning is the delivery of electronic learning materials on mobile computing devices that can be accessed anywhere and anytime. Thus students can access lesson material outside school hours. The concept of learning using mobile learning media can provide many benefits, both for students and teachers.

The use of mobile learning is very supportive for the learning process carried out by conventional methods. Learning material provided in the classroom usually comes from textbooks, modules and worksheets. The material can be supplemented with material provided through mobile learning that can be obtained from other sources such as articles, papers or journals from the internet. Students get additional teaching materials and learning materials optimally without being limited to class hours according to school schedules.

The results of a preliminary study at SDN 1 Kalikoa, Cirebon Regency, revealed that they had never used mobile learning as a learning media for mathematics, even though Android smartphones had been widely used by students and teachers. In addition, learning process in classroom is still in teacher centred mode, so the students only get material from one source. Limitations of class hours and the use of less attractive learning methods affect student learning outcomes. The existing learning system in schools generally strictly limits the use of space and lesson time and the number of face-to-face hours (Ahmadi, 2009). Learning activities where students just sit quietly and listen to the materials from the teacher seems to have been entrenched long ago, so to make changes towards active, creative, and fun learning is rather difficult. This condition causes the students to have low learning autonomous.

Media in the learning process is defined as all forms of physical communication equipment in the form of software and hardware which is a small part of learning technology that must be

created or developed, used and managed for learning needs in achieving the effectiveness and efficiency of the learning process. The development of learning media must pay attention to ease of use, attractiveness, and usefulness. The criteria for a good learning media ideally include four main factors, namely relevance, ease, attractiveness and usefulness. Mathematics mobile learning media is an alternative learning media that has unique characteristics, which can be used anywhere and anytime, and supported by interesting visualizations.

By using mathematics mobile learning media, the students will be able to learn independently and improve their learning outcomes. Autonomous in learning is learning activities that take place more driven by their own will, their own choices and own responsibilities. Students need to have autonomous in learning so that they are responsible for regulating and disciplining themselves and in developing learning skills on their own volition. This is in line with Suhendri (2011) that learning autonomous is an important element in learning mathematics. Students can improve their understanding of mathematics and like mathematics as a fun learning through learning media. Lin (2013) said that the use of media in the form of web applications can improve students' performance regarding the rapid use of Information and Communication Technology (ICT) in the field of education. Teachers have used learning media only as informative aspect of the lesson without paying attention to students' attractiveness, so that an attractive learning media is needed to attract students' attention. Utilization of mobile learning media can improve students' autonomous and learning outcomes as stated by Forment & Guerrero (2008) that mobile-based media are flexible, can be used repeatedly according to the readiness and willingness of students. The use or repeated learning with high frequency can improve students' learning outcomes.

This study aims to develop a mathematics mobile learning media, the effectiveness of the use of media developed and to know the practicality of the media developed. Research on the development of mathematics mobile learning media in fractional material is expected to help teachers in delivering material as well as improving students' autonomous and learning outcomes significantly.

METHODS

This study included research and development that adapted the ADDIE model. This model was chosen because it has steps that are simple, systematic, and easy to implement in the field. There are five stages in the ADDIE model research and development namely Analysis, Design, Development, Implementation, Evalution.

This research was conducted in SDN 1 Kalikoa, the research was carried out in the odd semester of the 2018/2019 school year. The subjects in this study consisted of material experts, namely experts in mathematics learning, instructional media experts, information and technology experts, teachers, peer reviewers, 3 students for individual trials, 9 students for small group trials, and 2 classes for class experiment and control class consisting of 30 students each. The empirical trial design used is as follows (Sugiyono, 2015).

E	O_1	X	O_2
K	O_3	-	O_4

Figure 1. Research Design

Information:

X : Treatment given to the experimental class using mobile learning media

– : Treatment given to the control class by using a piece of paper learning media

O_1 : Students' learning outcomes before being given treatment in the experimental class

O_2 : Students' learning outcomes after being given treatment in the experimental class

O_3 : Students' learning outcomes before being given treatment to the control class

O_4 : Students' learning outcomes after being given treatment to the control class

Media products were validated by media experts, material experts and information

technology experts. Media assessments were also conducted by teachers and peer reviewers. The results of the assessment and comments were used for media improvement in the next stage. Media was then tested limited to students. Student results and comments were used for media improvement. The media was then tested on a field scale in the control class and experimental class. The results of field trials were used for media improvement to obtain the final product of mathematics mobile learning media. Students' autonomous and learning outcomes were measured during the mobile learning media trial. The autonomous questionnaire and test instruments were given before and after the learning.

Data collection in this study used an assessment questionnaire, autonomous questionnaire, and test instruments. Media appraisal data was obtained using a questionnaire assessment by media experts, material experts, information technology experts, teachers, peer reviewers and students. Data on increasing students' autonomous was obtained by using an independent questionnaire and observation sheet. Improved data on learning outcomes was obtained from student test instruments.

Data obtained through trials were classified into two mode, namely qualitative and quantitative data. Qualitative data in the form of comments and suggestions raised by media experts, material experts, mathematical teachers, peer reviewers and students were collected to improve learning media products. For quantitative data in the form of scores to determine the effectiveness of the product on learning autonomous and cognitive learning outcomes students were analyzed by comparing the pretest and posttest data between the experimental class and the control class.

The data analysis technique used to analyze the learning outcomes of students is the t-test. The t-test aims to determine the significance of the difference between the average value of students' learning outcomes of experimental class and control class. In this study, students' learning outcomes were measured by assessments in the form of cognitive tests. Before the t-test was carried out, the requirements were tested first, namely the normality test and homogeneity test. Normality test was carried out with kolmogorov smirnov and homogeneity test using homogeneity of variance. If the requirements are fulfilled, the data is analyzed by t-test (independent sample t-test), the data tested in the t test is the final learning data that meets the requirements test.

RESULTS AND DISCUSSION

Needs Analysis

In the analysis phase the needs analysis and analysis of students are carried out. Need analysis is done to determine the fundamental problems faced by students in terms of mathematics learning, especially fractions. Needs analysis in this study was carried out in several stages, namely observation of learning activities and learning tools used. Based on the results of the initial field study it was found that learning was still teacher-centered and that mobile phones or gadgets had not been used as learning media, even though teachers and students at SDN 1 Kalikoa Cirebon Regency had an average mobile phone with advanced features.

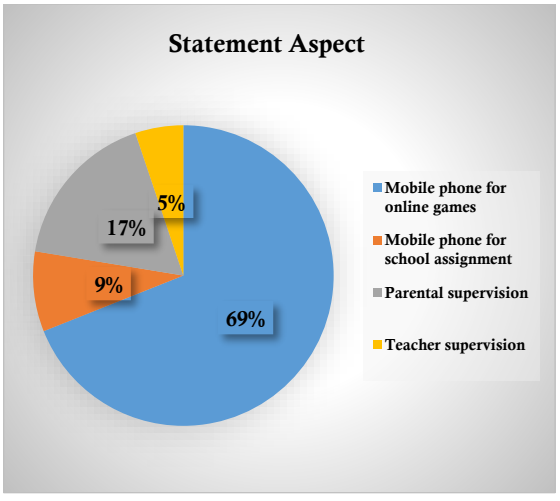

Figure 2. The Results of Using Mobile Phones to Access Learning at SDN 1 Kalikoa

Student analysis was done to adjust the material and learning media with the target of users, elementary school students (SD). Elementary students include those who enjoy

video, audio and kinesthetic. In this phase, it is expected that students can be directed to learn the given material. In fractional material students learn to understand the meaning of fractions, simplify fractions, compare fractions, and sort fractions. Elementary students will not have much difficulty with technological developments when they have to learn to use mobile learning.

Initial Product Design

The design stage is carried out to design the learning media developed. The media developed was mathematics mobile learning on fractional material. The design phase included the preparation of tests and the selection of media formats for mobile learning in mathematics. The test in this study was used to measure the improvement of students' cognitive learning outcomes through the use of mobile learning. Tests were prepared based on basic competencies, and indicators of learning achievement. This test consists of two tests, pretest and posttest. Pretest was given to students before using mathematics mobile learning media in fractional material, and posttest was given to students after using mathematics mobile learning media in fraction material.

The selection of the mobile learning media format was made as follows. (1) consists of basic competency buttons & indicators, materials, exercises, videos, profiles, and exit; (2) the material displayed on the android screen can be scroll down; (3) videos made relating to the material being studied; (4) the image is made in color. (5) the exercise is given a timer; (6) the results of training values can be saved in image format.

Development

Assessment of mathematics mobile learning media by media experts, information technology experts, teachers and peer reviewers viewed from the aspect of display quality and software engineering is presented in Table 1.

The number of scores from the assessment of learning media by media experts, information technology experts, teachers and peer reviewers for the aspects of display quality and software engineering was 187.9 with very good criteria. The result of assessment for aspects of interface, reusable, maintainable, compatibility with a total of 198.2 including very good criteria. Based on the assessment, it shows that mobile learning mathematics media products are declared feasible to be tested.

Assessment of mathematics mobile learning media by media experts, teachers and peer reviewers viewed from the aspects of interface, reusable, maintainable, compatibility is presented in Table 2.

Table 1. The Results of Assessment Based on The Aspects of Display Quality and Software Engineering

Aspects	The amount of item	Average score	Criteria
Display quality	7	98.6	Very good
Software engineering	3	89.3	Very good
Total	10	187.9	Very good

Table 2. The Result of Assessment Based on Interface, Reusable, Maintainable, Compatibility

Aspects	The amount of item	Average score	Criteria
Interface	7	99.2	Very good
Reusable, maintainable, compatibility	3	99	Very good
Total	10	198.2	Very good

Assessment of mathematics mobile learning media by material experts, teachers, and peer reviewers based on material aspects can be seen in Table 3.

Table 3. The Results of Assessment Based on Material Aspects

Aspects	The amount of item	Average score	Criteria
Material	13	97.3	Very good
Total	13	97.3	Very good

The number of assessment results based on material aspects is 97.3 with a great criteria. Based on the results of the assessment that has been done illustrates that the mathematics mobile learning media products are proper to be tested, because it has a great category based on material aspect.

Generally, the practical results of the mathematics mobile learning media in terms of the student's responses get an average rating result of 88% with a very practical category. The analysis results for the effectiveness of the mathematics mobile learning media in terms of student's learning outcomes are taken from score withdrawal which is cognitive tests. Learning outcomes data were obtained from pretest and posttest. The pretest and posttest scores of the experimental class and control class are shown in Table 4 below.

Table 4. The Scores of Pretest and Posttest The Students' Learning Outcomes of Experimental (E) and Control Classes (K)

Data	Class	N	Ideal score	Min. score	Max. score	Average	P (%)	Explanation (exp.)
Pretest	E	30	100	12	28	19.86	20	D
	K	30	100	12	32	19.66	20	D
Postest	E	30	100	58	82	69.73	70	B
	K	30	100	38	60	49.33	49	C

Table 4 can be seen that the average initial score of the experimental class learning outcomes is 19.86 while the control class is 19.66 that both of them included in the medium category. The score increases after learning is conducted, the average score achieved by students in the experimental class is 69.73 while the control class is 49.33. The experimental class which get a higher scores was the class that used the mobile learning media .

Before learning was carried out, the student learning outcomes of the two classes researched were in the category D (poor). After learning was carried out, the level of the student learning outcomes in the experimental class reached category B (high) and the control class reached the category C (medium).

The different test of 2 mean statistically was conducted to know the differences score of pretest and posttest scores between the 2 classes researched. In the posttest, normality test and homogeneity test had been done which were all distributed normally. Then, to find out the difference between the pretest and posttest scores so the gain test was obtained.

The gain score test was conducted to determine the difference between the pretest and posttest scores. The gain test was carried out after all prerequisite tests were completed, both normality and homogeneity tests. Based on the normality test and homogeneity test was known that the data was distributed normal and homogeneous, then the gain score test was performed. The results of the N-Gain test can be seen in Table 5 below.

Table 5. The Result Test N-Gain

Group	Average		N-Gain	Criteria
	Pretest	Posttest		
Experiment class	19.86	69.73	0.62	Medium
Control class	19.66	49.33	0.36	Medium

Table 5 can be seen that the results of N-Gain in the experimental class shows 0.62 and N-Gain in the control class shows 0.36. The N-Gain classification is as follows: $g \leq 0.30$ = low, 0.30 <g> 0.70 = medium, $g \geq 0.70$ = high. The N-gain results of the experimental class shows 0.62 so that they are in the medium category. The N-gain in the control class is 0.36 so that it belongs to the medium category. We can conclude the results of the gain test that the difference in the experimental class is higher than that of the control class so that it can be concluded that the learning in the experimental class is better than the control class. Then to prove the hypothesis so that it is proceed with the t-test.

In the hypothesis test, there were several provisions that must be used as guidelines. These provisions were if $t_{value} < t_{table}$ or the significance value > 0.05, then h_0 was accepted, and if $t_{value} > t_{table}$ or significant value < 0.0, then H_0 was rejected. The result of the calculation hypothesis test using SPSS version 23 independent sample t test results can be seen in Table 6.

Table 6. It is known that the data in the research are homogeneous, so to find out the results of hypothesis test can be seen in the column of equal variances assumed. Conversely, if it is not homogeneous, to find out the results of hypothesis test can be seen in the column of equal variances not assumed. Based on the results of calculations with SPSS version 23, the column equal variances assumed can be seen that the value of t_{value} = 13.269 and its significance is

0.000. From the calculation results, it can be seen that 13.269 > 2.000 or $t_{value} \geq t_{table}$ and 0.000 < 0.005 or significance value < 0.05. According to the valid provisions for the hypothesis test that the researcher has described above, then H_0 is rejected. Thus, it can be concluded that the students' learning outcomes of the experimental class that used the mathematics mobile learning media get a higher average score than the control class students.

Table 6. The Results of t-Test Analysis

		t-test for Equality of Means						
		t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference	
							Lower	Upper
Score	Equal variances assumed	13.26	58	.000	20.40	1.53	17.32	23.47
	Equal variances not assumed	13.26	58.52	.000	20.40	1.53	17.32	23.47

The analysis results of the experimental and control class observation sheet can be seen in Table 7 .

Table 7. The Result of N-gain Experiment dan Control Class

Group	Average learning autonomous		N-Gain	Criteria
	Pretest	Posttest		
Experiment class	47.56	99.73	0.99	High
Control class	41.13	81.83	0.69	Medium

The analysis results of the of the experimental and control class observation sheet can be seen in Table 8.

According to table 7, it is obtained an improvement in the average learning autonomous of the experimental class students 0.99 with high criteria and 0.69 for the control class with low criteria. This data is based on students' pretest and posttest results.

Table 8. The Analysis Results of The Experiment and Control Class Observation Sheet

Class	Autonomous aspect					Average score	Criteria
	Confidence	Ability to determine options	Initiative	Adaptation	Responsible		
Eksperiment	77.22	92.77	77	92.22	75	82.84	Very good
Control	67.5	80.55	64	87.2	68.33	73.52	Good

From table 8 it can be seen that the experimental class observation sheet analysis in each aspect is greater than the control class. The average score of the experimental class is 82.84 and the control class is 73.52. It is obvious that during the learning process, the learning autonomous of the experimental class students is greater than the control class.

The mathematics mobile learning media has characteristics, they are interesting visualization, practical and flexible that can be used anytime and anywhere, therefore that students can repeat the material independently without being bound by the time and the place and it can improve memory skill about the material. This statement is in accordance with the results of Chuang & Chen (2007) research that digital learning media could facilitate students in learning whenever and wherever and it could improve the autonomous and memory of students, because it could be used repeatedly. Similar results were also conveyed by Sakatet al. (2012) that using technology-based learning media was able to increase motivation, because learning was more attractive, so learning became more interesting and enjoyable.

CONCLUSION

Based on the results of the study it can be concluded that mathematics mobile learning can be used as an alternative learning media that can improve learning autonomous and learning outcomes of elementary students. The prominent advantage of this Android-based learning media is its flexibility to be used anywhere and anytime without being bound by the time and the space. This advantage is supported by android devices

that are small, light, and easy to carry anywhere. In addition, the existence of this Android-based learning media can improve the use of mobile devices or tablets as learning media for students (Calimag, et al. 2014). The results of this research are in accordance with research conducted by Jeng, et al. (2010) which showed that mobile technology had advantages, they were providing convenience in contextual learning, and related with the daily lives of students.

Besides there are many advantages, limitations of this research, including: (1) not all students had devices that support the mobile learning media of mathematics; and (2) there were only practice questions, there was no evaluation problem in the mobile learning mathematics.

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