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The Effectiveness of E-learning Media with Guided Discovery Method from The Perspective of Student's Mathematics Problem Solving Skill

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Abstract. The aim of this research is to find out the effectiveness of e-learning media with guided discovery method from the perspective of student's mathematics problem solving skill. The method used in this research is quasi experiment with nonequivalent comparison group design. This design used one experiment class and one control class. The subject of this research is 79 eight grade students. This research took 5 sessions for treatment and 2 sessions for the test. The instrument used here is essay test instrument about mathematics problem solving. The students in experiment and control classes were given pretest and posttest. The learning activity used in experiment class is e-learning media with guided discovery method while for control class is guided discovery. The result shows that the problem solving in experiment class is better than control class, so it can be concluded that e-learning media with guided discovery method effective from the perspective of student's mathematics problem solving skill.

INTRODUCTION

Mathematics problem solving skill is one of the essential abilities for every student to master. Problem solving as the special activity for mathematic is highly important for learning activity [1]. Jonassen [2] considers the problem solving as the most significant cognitive aim of either formal and informal education in educational context. This is not a new issue in curriculum, because the previous research by Meagher, Edwards, and Ozgub-Koca [3] showed that many teachers still have difficulty in applying problem solving assignment in mathematic.

Problem solving skill is the ability of student to analyze and select appropriate mathematic solving strategy in order to find solution for not routine and contextual problem [4], [5], [6], [7], [8], [9], [10]. There are four steps to solve problem based on Polya [11], they are understanding the problem, devising a plan, carry out the plan and looking back. Based on Bransford & Stein (1993) in Santrock [6], there are also four phases in solving problems, which are searching and understanding the problem, planning a good strategy, exploring, rethinking and redefining the problem and solution from time to time. However, according to Yu, Fan, and Lin [12], there are seven steps in solving problems which are (1) defining and analyzing the problem, (2) collecting data, (3) finding potential solution, (4) choosing the optimum solution, (5) applying the optimum solution, (6) evaluating, dan (7) revising solution based on the result. This study use problem solving steps by Polya. Kennedy, Tipps, dan Johnson [13] said there are eleven problem solving strategies: (1) Find and use a pattern, (2) Act it out, (3) Build a model, (4) Draw a picture or diagram, (5) Make a table and/or a graph, (6) Write a mathematical sentence, (7) Guess and

check, or trial and error, (8) Account for all possibilities, (9) Solve a simpler problem, or break the problem into parts, (10) Work backward, and (9) Break set, or change point of view.

Even though the problem solving skill is essential for every student, some students are found to have low problem solving skill. Tambychik and Meerah [14] stated that many students find difficulty in mathematics especially in problem solving. Based on some previous research [15], [16], [17], [18] it is proven that the problem solving skill of junior high school students are still low.

Teaching media is one of the most significant aspects in learning activity. In respond to this, teachers should master three main components of knowledge which are content, pedagogy, and technology [19]. Therefore, teachers should be able to use effective media and teaching approach as well as being able to evaluate the teaching quality [20], one of them is technology-based teaching. It is generally known technology development is rapid and advance. Moreover, it is used widely in many aspects of life including educational area. In this digital era, the use of information communication and technonlogy that spread all over is needed in many aspects of life including education [21]. In line with this, it is stated that the use Information Communication and Technonlogy (ICT) can help students in learning mathematic [22].

The result of a survey conducted by APJII (Asosiasi Penyelenggara Jasa Internet Indonesia) in 2016 about the use of internet based on occupation, it is discovered that from 132.7 million users (51.5% from the total amount of Indonesian population which is 256.2 million people), 6.3% or 8.3 million students use the internet. There is 9.2% or 12.2 million internet use related to education, which shows that the use of internet for education is still low. From the survey we can see that there are students including junior high school students that use internet even though only a few of them use it for educational purposes.

One of the practices of ICT in education is e-learning. E-learning is teaching media that use technology such as computer and internet. E- learning media is a media that uses device such as computer and other electronic devices together with communication network such as internet [23], [7], [20], [24], [25].

The benefit of e-learning media with online system for students in learning mathematic are gaining additional knowledge, space for discussion that can tighten the bond between students and teacher [26] also fun learning activity for students and teachers [22]. In Dedi Rohendi's study [22], it is found that students that use e-learning media have better result in connecting the mathematic skills of the students than the one who learn through conventional learning.

According to Garrison and Kanuka [27] there are three kinds of learning; enhanced, blended, and online. Cited from Allen, Seaman, and Garrett [28] that web facilitated is learning activity that use web to support the activity. (1-29% online learning), blended is learning activity that combine conventional learning with online learning (30-79% online learning), online is a learning activity that is mainly online (80+% online). During this research, the researcher will use enhanced e-learning. e-learning media that will be used is Schoology.

The use of e-learning media outside the classroom can be combined with guided discovery method for instruction in the classroom. LMS (Learning Management System) which also belongs to e-learning can be combined with guided discovery method that can reduce the students' failure in learning [29]. Dalgarno, Kennedy, and Bennett [30] recommend that e-learning (computer based simulation) should be combined with guided discovery method. In discovery method, teacher should be able to guide and apply the technology [31].

Discovery method is a method that involves students actively in learning where students find their own knowledge [32], [33], [34]. There are three types of discovery method according to Mayer [35] that is pure discovery, guided discovery, and expository. This study employed guided discovery method. The guided discovery method is one of discovery methods in which students are guided by the teacher to find information or solution to the problems [36], [37]. According to Achera [38] the learning steps use guided discovery method that is motivation, exploration, presentation, wrap up, practice, and evaluation.

Some studies have proven that the use of technology in learning has a positive effect on problem-solving abilities. Study on engineering students found that engineering students are very satisfied using problem-solving methods with e-learning system [8]. Design research on Web-based collaborative learning on statistics students can develop problem-solving skills [39]. Study using computer based instructional in grade 4 students can develop problem solving ability of mathematics [40]. E-learning has a positive effect on the problem-solving skills of class 5 students on science and technology learning [41]. Therefore, the aim of this research is to know the effectiveness of e-learning media with guided discovery method from the perspective of problem solving skill of 8 grade students in mathematics.

METHOD

Participants were 79 eight grade students of one of middle schools located in Indonesia. In Indonesian education system, eight grade students' age range is between 13 and 15 years old. Data were collected from two different classes in which 40 students are from experimental class and 39 students are from control class. The experimental class given a treatment with guided discovery method and application of e-learning media, while in the control class was given treatment in the form of learning with guided discovery method but e-learning media is excluded. Moreover, the e-learning media used is the Schoology application. Schoology is used by teachers to upload student tasks and also as a mean of discussion forum between teachers with students or students with other students. In the classroom, guided discovery method with Student Worksheet is employed.

The instrument used in this research is mathematical problem solving pretest and posttest that were given to both the experimental class and control class. Mathematical problem solving pretest and posttest each consist of 5 essay questions. The test covered the circle topics in the second semester of the eight grade mathematics curriculum. Pretest is given before the students learn the material of the circle while posttest is given after learning the material circle. The study took 5 sessions for treatment and 2 sessions for the test.

Validity proof of students' problem solving instrument is obtained through content validity and construct validity. The proof of content validity is obtained from expert judgment. Construct validity is obtained from factor analysis towards the result of instrument test in one class outside of experiment and control class by looking at the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) results and the significant value in Bartlett's Test of Sphericity. If the value of KMO > 0.50 then the representative of the sample in the analysis has been fulfilled. If a significant value on Bartlett's Test of Sphericity < 0.05 then the instrument is valid. Estimation reliability of test instrument using alpha cronbach.

Mathematics learning with e-learning media with guided discovery method is said to be effective in regards to the problem solved skill if the average score of experiment class is higher than the control class. Normality assumption test in this research using Shapiro-Wilk. If the value of Shapiro-Wilk significance in each group is higher than the 0.05, it can be concluded that both groups are from a normally distributed population. Test of homogeneity assumption seen from result of Lavene's Test. If the value of Lavene's Test significance is higher than 0.05, it can be concluded that the pretest data from the experiment and the control class are homogen. If data are Normal and homogen, data can be hypothesis using independent sample t-test. If the value of 2-tailed significance is less than 0.05, it means that problem solving score of the experiment class is higher than the control class. If data in the experiment and control class are normally distributed but not homogeneous, so to test the hypothesis, the formula to use is

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\left(\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}\right)}} \tag{1}$$

with degree freedom

$$v = \frac{\left(\frac{{s_1}^2}{n_1} + \frac{{s_2}^2}{n_2}\right)^2}{\frac{\left(\frac{{s_1}^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{{s_2}^2}{n_2}\right)^2}{n_2 - 1}} \tag{2}$$

In which $\overline{x_1}$ = average score of experiment class, $\overline{x_2}$ = average score of control class, ${s_1}^2$ = variant of experiment class samples, ${s_2}^2$ = variant of control class sample, n_1 = number of sample in experiment class, n_2 = number of sample in control class [42]. If *t* values are higher than *t* table with a significance level of 0.05 then the mean score of problem solving the experiment class is higher than the control class.

RESULTS AND DISCUSSION

The learning used in the experimental class was guided discovery method and 1-29% of online learning conducted in the classroom. Teachers uploaded Worksheet in schoology that will be discussed by students in the class, after students downloaded and discussed Worksheet with their group, then teachers and students discussed and concluded the discussion result together. After concluding the results of the discussion, the teacher assigned a question of the day task that was uploaded in the schoology to be done by the students. Question of the day was given in every meeting. Schoology was also used outside the classroom which means of teacher discussions with

students and students with students. Examples of the look of schoology can be seen in Figures 1. Fig. 2 is an example of teacher and student discussion in schoology.

FIGURE 1. Example of The Look of Schoology

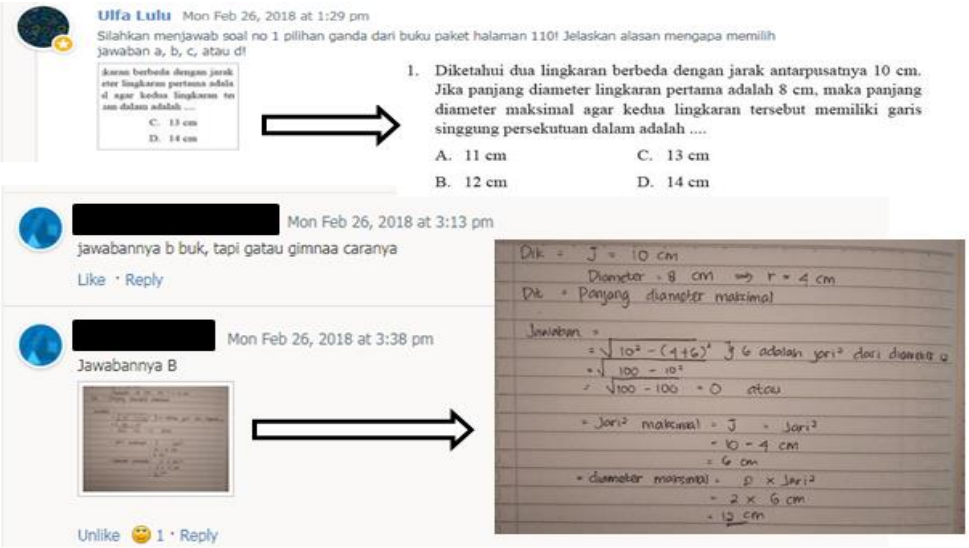

FIGURE 2. Example of Teacher and Student Discussion in Schoology

Learning activity in the control class only used guided discovery method. The teacher gave Worksheet to the students in the class and the students discussed the Worksheet with their group. After that the teachers and students discussed and summarized the results of the discussion together.

Trial of pretest and posttest of problem solving before being administered to research subjects by calculating proof of validity, reliability estimation, and SEM. The test of the instrument was given to the subjects other than the subject of the study. The test results of pretest and posttest instruments can be seen in table 1.

TABLE 1. The Test Results of Pretest and Posttest Instruments

	KMO	Sig. (Bartlett's Test)	Alpha Cronbach
Pretest	0.53	0.00	0.61
Posttest	0.62	0.00	0,66

From table 1, the pretest instrument has KMO 0.53, where 0.53 > 0.50 so that it can be said that the representative of the sample in the analysis has been fulfilled. Bartlett's Test of Sphericity shows sig. 0.00, where 0.00 <0.05 so it can be said that the pretest instrument is valid. The alpha cronbach is 0.61 so that the instrument pretest can be said reliable. While the posttest instrument has a value of KMO 0.62, where 0.62 > 0.50 so it can be said that the representative of the sample in the analysis has been fulfilled. Bartlett's Test of Sphericity shows sig. 0.00, where 0.00 <0.05 so it can be said that the posttest instrument is valid. The alpha cronbach is 0.66 so that the posttest instrument can be said reliable.

Before treatment, all 40 students in the experiment class and 39 students in the control class were given pretest. Pretest is given to identifywhich students in experiment or control class undergo the same problem solving ability. The pretest results of the experiment class and the control class are shown in table 2.

TABLE 2. Results of Pretest Data

	N	*Theoritic Score*		*Observation Score*		*Mean*	*Std. Deviation*	*Variance*
		Min.	**Max**	**Min.**	**Max.**			
Experiment	40	0	100	13.64	31.82	22.88	4.39	19.25
Control	39	0	100	15.91	36.36	24.24	5.50	30.27

In table 2, it is discovered that the minimum pretest score in the experiment class is 13.64 while the maximum score was 31.82 of the maximum ideal score was 100. The average pretest score in the experiment class was 22.88. The minimum pretest score on the control class was 15.91 while the maximum score is 36.36 of the maximum ideal score was 100. The average pretest score in the control class was 24.24. It can be seen that the average pretest score of the experimental and control classes had a slight different. In order to prove that the experiment class and the control class face similar problem solving ability, it is then necessary to test the hypothesis.

From the result of Shapiro-Wilk, the significance level in the experimental class was 0.21, where 0.21 > 0.05 so it can be concluded that the pretest data in the experiment class was normally distributed. The level of significance in the control class was 0.15, where 0.15 > 0.05 can be said that the pretest data in the control class was normally distributed as well. From Lavene's Test results, the significance level is 0.12, where 0.12 > 0.05 can be stated that the pretest data in the experiment and control class was homogen.From the Independent Sample T-Test results, the 2-tailed significance level is 0.23, where 0.23 > 0.05 so it can be concluded that there was no difference in the average pretest score in the experimental class and the control class or the students in the experimental class and the control class have the same problem solving ability.

After treatment, both experimental class and control class were given a posttest. The posttest results of the experiment and the control class areshown in table 3.

TABLE 3. Results of Posttest Data

	N	*Theoritic Score*		*Observation Score*		*Mean*	*Std. Deviation*	*Variance*
		Min.	Max	Min.	Max.			
Experiment	40	0	100	65.31	100	83.93	10.26	105.34
Control	39	0	100	67.35	97.96	79.54	6.84	46.79

In table 3, it was discovered that the minimum posttest score in the experiment class was 65.31 while the maximum score was 100 of the ideal maximum score of 100. The mean posttest score in the experimental class was 83.93. The minimum posttest score in the control class is 67.35 while the maximum score is 97.96 of the ideal maximum score is 100. The mean posttest score in the control class is 79.54. It can be seen that the average posttest grade of the experimental class is better than the control class. In order to prove that the experiment and the control class have differences on the average score, it is necessary to test the hypothesis first.

From Shapiro-Wilk results, the significance level in the experimental class is 0.06, where 0.06 > 0.05 so it can be concluded that the posttest data in the experimental class is normally distributed. The level of significance in the control class is 0.09, where 0.09> 0.05 can be said that the posttest data in the control class is normally distributed. From Lavene's Test results, the significance level is 0.002, where 0.002 < 0.05 so it can be concluded that the posttest data in the experimental and control class are not homogen. Posttest data in the experimental class and control class are normally distributed but not homogen. Obtained t value = 2.24 and $t_{(\alpha,v)} = t_{(0.05,68)}$ =2.00, where 2.24 > 2.00, then it can be concluded that learning of mathematics uses e-learning media with guided discovery method effective from the perspective of student's mathematics problem solving skill.

Problem-solving ability of the experiment class is higher than the control class is most likely due to the students in the experiment class getting a chance to discuss using e-learning rather than the control class. The advantage of e-learning media with online system for students in learning mathematics is to gain additional knowledge, provide space for discussion [27]. Collaborative activities can develop students' mathematical understanding [44]. Students who have a good mathematical understanding will be easy to solve problems in mathematics [45].

The study results is relevant to research conducted by Lin [40] who use Web-based collaborative learning design using Moodle applications. Her study took a sample of 31 statistical students. The results show that Web-based collaborative learning design can develop problem-solving skills. The study by Lazakidou & Retalis [41] who took a sample of seventh grade students showed the result that computer-based instruction can develop

problem solving skills of mathematics. The study by Herdiana, Wahyudin, and Sispiyati [46] who took a sample of 70 students of class VII, resulted in that learning with discovery method can support developing students' math problem solving skills. The study by Murni, Sariyasa and Ardana [47], which captured a population of 181 8th grade students, resulted in a mathematical problem-solving ability using guided discovery methods with GeoGebra media was better than students' mathematical problem-solving abilities using conventional learning.

Here are some examples of student work in solving one of the problem-solving matter of circle matter. Fig. 3 was one of the problem solving question. Figures 4 and 5 are examples of student problem solving strategies using image-making strategies. Although using the same strategy that makes the image but looked different ways students solve problems. Fig. 4 looked at how students tend to solve problems by communicating while in Figure 5, students tend to make more drawings to solve problems.

1. Ibu ingin menyimpan 12 kaleng susu berbentuk tabung yang alas dan tutupnya berbentuk lingkaran dengan jari-jari 7 *cm*. Ibu memiliki 5 kotak yang alas dan tutupnya berbentuk persegi dengan panjang sisi 30 *cm* untuk menyimpan kaleng-kaleng susu. Setiap kotak harus dapat terisi penuh dengan kaleng-kaleng susu tersebut. Berapa kotak yang tidak digunakan oleh Ibu? Berapa jumlah luas keseluruhan tutup kaleng dalam 1 kotak?

FIGURE 3. Example of Problem Solving Question

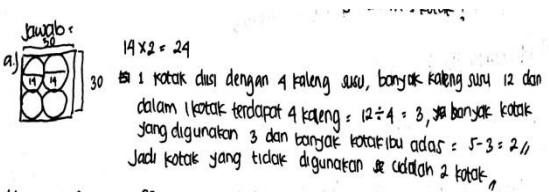

FIGURE 5. Student Problem Solving Strategy

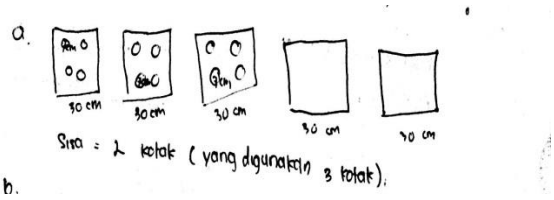

FIGURE 6. Student Problem Solving Strategy

CONCLUSION

This research used two classes, experiment and control class. Learning in experiment class used e-learning media with guided discovery method while learning in control class only used guided discovery method. In the experiment and control classes each were given pretest and posttest. From the results of the study and discussion, pretest results showed that both classes have the same problem solving ability. Posttest results show that the mean posttest score of the experiment class was higher than the control class. The mean posttest score in the experiment class was 83.93 while the mean posttest score in the control class was 79.54. So, it can be concluded that the e-learning media with guided discovery method effective from the perspective of student's mathematics problem solving skill.

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