Information and Communication Technologies to Improve Problem Solving and Self-Efficacy: Exploring Geometry Learning Using Dynamic Mathematics Software Geogebra

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Abstract

Information and communication technologies can support learning of geometry through geogebra software. This study aimed to investigate the effectiveness of dynamic mathematics software geogebra towards problem solving and self-efficacy. Seventy-four university students divided to one class assigned as geogebra assisted learning and the other as using conventional learning. The results showed a significant difference of problem solving between these two groups statistically. Additionally, The results showed that there is a significant difference of self-efficacy between these two groups statistically. The results indicates that the problem solving and sef-efficacy of the university students using geogebra assisted better than using conventional learning. We can conclude that the dynamic mathematics software geogebra is effective to improve problem solving and self-efficacy.
Keywords: geogebra, problem solving, self-efficacy

INTRODUCTION

One of the challenges in mathematics teaching is assisting students to become skilled problem solvers, not memorizers (Granberg and Olson, 2015). It needs a comprehensive set of mathematical skills to solve the problems. However, many students have not acquired the basic skills in mathematics (Ali and Desa, 2004; Berch & Mazzocco 2007). In the previous studies by Tay Lay Heong (2005), Tarzimah (2005), and Kiat (1995) found that many students have problems in mathematics problem solving. While, problem solving is an important part of mathematics teaching, so students should be given opportunities to practice problem solving on a regular schedule (Kilpatrick, Swafford, & Findell, 2001).

Problem solving is important in math classes, because one of the purposes of teaching mathematics is to improve students' problem-solving skill which could be used in daily life activities (Yilmaz, 2007). The advancements of mathematics area demonstrate that students should develop their problem-solving skills. As Sahin (2007) found that the students who develop their ability and habit of problem solving during their school years become individuals

who can handle problems in the community in the future. Beside problem solving, students also need self-efficay in daily life to support their problem solving.

In education, self–efficacy has been widely applied (Beas & Salanova, 2006). The concept of self-efficacy was widely applied in Social Cognitive (Bandura, 2001). In this way, self-efficacy produces beliefs in cognitive, affective, motivational, and selective processes (Bandura, 1997).

El Islami, et al (2015) implemented the inquiry learning to improve the self - efficacy of the university students, the report of this study is there is an improvement of self -efficacy of students by inquiry learning, but not difference statistically to conventional learning. Another previous study, El Islami et al (2015) correlate the self-efficacy with scientific literacy, the report of this study is there is no correlate between self-efficacy with scientific literacy. According to Damanhuri, Hakim, and Mukhtar (2015) state that self-efficacy also affects the achievement of learning. This previous study in line with Wolters & Rosenthal, (2000) that found that students with higher levels of self-efficacy set higher purposes, employ more effort, persist longer in the face of challenge and are more liable to apply self-regulated learning approaches.

In mathematics, self – efficacy refers to the believeness to perform mathematics successfully (Burnham, 2011). Efficacy in mathematics is essential and in our technological society, self – efficacy plays an important role (Anthony and Walshaw 2007). Mathematics self–efficacy is a student's assessment of ability to solve problem successfully in the areas of geometry, arithmetic, measurement, and algebra (Bandura and Schunk 1981; Schunk and Pajares 2009). In this study, we will focus on geometry teaching that use geogebra.

In a traditional geometry instruction, students do not discover geometric relationship, nor invent any mathematics (Maragos, 2004). Students can improve their geometry thinking skills in student – centered learning environments especially in geogebra (Battista, 2002). Issue in mathematics education, computer's roles should not be limited to teaching.

In the previous studies, Joubert (2013) used Geogebra software to support problem solving and conceptual understanding. Geogebra software can refer to concrete mathematical objects like geometric figures, algebraic expressions, and graphs (Sedig & Sumner, 2006). Geogebra software offers educators a resourceful teaching environment in which educators can create new ways to connect, extend, and enrich their instructional activities in order to improve student's understanding of mathematics concepts (Xistouri and Pitta-Pantazi, 2013).

Based on the gap, it is importan to conduct a research on geogebra, problem solving and self-efficacy. So, this study is aimed to to investigate the effectiveness of dynamic mathematics software geogebra towards problem solving and self-efficacy

METHOD

Design of the study

This study used a quasi-experimental method. This study will investigate the effectiveness of dynamic mathematics software geogebra towards problem solving and self-efficacy using experimental and control classess with design in Table 1.

Table 1. Nonequivalent pretest-posttest control group design

Group	Independent Variable		
Geogebra assisted (E)	Y1	X	Y2
Convensional (C)	Y1	---	Y2

Note:

E – Geogebra assisted	Y1 – pretest	X	GeoGebra Teaching Strategy (GTS)
C – Convensional	Y2 – posttest	---	Conventional Teaching Strategy (CTS)

Research Procedure

This study was conducted in the 2016-2017 academic year with 74 university students who had taken a course about mathematics education software during a year at one public university in Indonesia. They had learned to use Geogebra softwares in the second semester. They participated weekly in two-hour lessons and they were asked to prepare Geogebra software activities weekly in one semester or 15 meetings. The instructor of provided extra guidance to the students in case they needed help during learning. Problem solving close-ended questionnaire was used to measure the university students' problem solving, and self-efficacy questionnaire to measure the the university students' self-efficacy

Data Analyses

The data of pretest and postest of problem solving between experimental and control classess will be calculated. Also, the data of pretest and postest of self-efficay between experimental and control classess will be calculated. Data of pretest both problem solving and self-efficacy between experimental and control classess will be tested to investigate the difference between those two classes statistically. After that the data of posttest both problem solving and self-efficacy between experimental and control classess will be tested to investigate the difference between those two classes statistically. This postest data will be used to investigate the the effectiveness of dynamic mathematics software geogebra towards problem solving and self-efficacy.

RESULTS AND DISCUSSION

Descriptive statistics and statistically test associated with the mean value of mathematical problem-solving skills are summarized in this section. The researchers compared the problem-solving abilities between students using learning with Geogebra assisted and conventional.

Problem Solving Ability

Statistic Descriptive

Data obtained and analyzed in this study include the problem solving of pretest and posttest in the experimental and control classes.

Table 2. Descriptive statistics pretest and posttest

Test	Geogebra assisted				Conventional				Maximum Score
	N	X_{Min}	X_{Mak}	$\breve{X}$	N	X_{Min}	X_{Mak}	$\breve{X}$	
Pretest	36	8	30	18.58	38	4	38	20.15	100
Postest	36	38	68	50.31	38	34	56	39.34	100

Table 2 shows that the mean value of pretest of mathematical problem-solving ability of conventional learning is better than Geogebra assisted, the difference is about 1.57. Then after the post-test the average value of the Geogebra assisted group is greater than the conventional learning with the difference around 10.97.

Pretest

The statistical results for the pretest of problem solving of both experimental and control classes are shown in Table 3:

Table 3. Results of the independent *t*-test on the pretest of problem solving of both experimental and control classes.

Classs	Pretest			
	Mean	S. D.	*t*-value	Sig (2 tailed)
Experimental (36)	18.58	4.58803	-1.208	.231
Control (38)	20.15	6.42010		

As it was expected, the difference between the tested groups, Experiment and Control, was not statistically significant at the level of significance of 0.05 (t = -1.208; p .231).

Thus, from the data analysis of the average of pretest that has been done, it can be concluded that the initial ability in the mathematical problem-solving ability aspects of students to geogebra-assisted groups and conventional learning groups equivalent before being given done.

Posttest

The results of the independent *t*-test on the posttest of both groups that can be seen in Table 4.

Table 4. Results of the independent *t*-test on the post test of problem solving both experimental and control classes.

	Posttest			
Class	Mean	S. D.	*t*-value	Sig (2 tailed)
Geogebra Assisted (36)	50.3056	6.98905	7.784	.000
Control (38)	39.3421	5.01498		

An independent samples t-test was conducted to compare the groups' posttest scores between Geogebra assisted and conventional. There was a statistically significant difference between the Geogebra assisted (*Mean* = 50.3056, *SD* = 6.98905) and the conventional (*Mean* = 39.3421, *SD* = 5.01498; *t*(36)= 4.83, *p*<.05, two-tailed) in terms of problem solving mathematics.

Self-Efficacy

As shown in Table 5, to find out the mean value of self-efficacy between experiment and conventional classes.

Table 5. Results of self-efficacy of the independent *t*-test on the posttest of self-efficacy of both experimental and control classes.

	Self-Efficacy			
Class	Mean	S. D.	*t*-value	Sig (2 tailed)
Geogebra Assisted (36)	79.2500	8.06890	2.764	.007
Control (38)	74.3947	6.96532		

The self-efficacy mean score of the experiment students is 79.25 with standard deviation of 8.068, while that of the conventional is 74.3947 with standard deviation of 6.96. The difference between the experiment and conventional mean scores is 28.30. Then the mean value of self-efficacy for the experiment class is more diffuse compared to the conventional class. This is evident from Table 5 with t = 2.764, p=.007. The implication is that there is significant difference between the self-efficacy mean scores of experiment and conventional students. This results indicates that the dynamic mathematics software geogebra is effective to improve self-efficacy. Self-efficacy as attitude is can be supported by application of computer assisted instruction enriched with use of geogebra as Aiken (1972) found.

The purpose of this research is to investigate the effectiveness of dynamic mathematics software geogebra to problem solving and self-efficacy. The results showed that based on group approach of learning, there is a significant difference between the problem-solving ability of mathematics students who follow the learning with Geogebra assisted and students who follow conventional learning. This results indicates that the dynamic mathematics software geogebra is effective to improve problem solving. This results can be supported by

Barron et al. (2007) that found that the geogebra software can make the powerful mathematical ideas that it uses to reformulate or create new ways of knowledge. In some literatures, the Geogebra assisted students in creating multiple representations of geometrical concepts and assisted avoid algebraic obstacles, allowing students to focus on geometric understanding (Iranzo & Fortuny, 2011). Another previous study Maricic, (2010) found that the geogebra is a well-suited study environment for problem solving

CONCLUSION

Based on the results we can conclude that the dynamic mathematics software geogebra is effective to improve problem solving and self-efficacy.

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