IOSR Journal of Research & Method in Education (IOSR-JRME)
e- ISSN: 2320–7388,p-ISSN: 2320–737X Volume 8, Issue 4 Ver. I (Jul. – Aug. 2018), PP 64-72
www.iosrjournals.org

Analysis of Eight Grade Students' Mathematical Problem Solving Ability based on Geogebra-assisted Learning Approach

Doni Irawan Saragih, Ani Minarni, Mukhtar
Mathematics Education Program, Post Graduate School
Universitas Negeri Medan, Indonesia
Correspondence author : Doni Irawan Saragih

Abstract: *The article is the report of research results that aimed to: (1) analyze students 'mathematical problem solving abilities that learned through Geogebra-assisted cooperative learning model and contextual learning model; (2) analyze joint influence of learning approach and gender to students' mathematical problem solving ability; (3) classifying students' mathematical problem solving. The instrument used is mathematical problem solving aability (MPSA) test. Data analysis was done through ANOVA. Results of research: (1) MPSA of the students in Geogebra assisted cooperative learning classroom is better than their counterpart in Geogebra assisted contextual learning classroom, (2) there is joint influence of learning approach and gender to student's MPSA, (3) MPSA of the students at the classroom belong to good category.*
Keywords: *Learning approach, Mathematical problem solving ability*

Date of Submission: 04-07-2018 Date of acceptance: 21-07-2018

I. Introduction

Education is all learning activities that take place throughout the ages in all situations of life activities. Education takes place in all kinds, forms and levels of the environment, which then encourages the growth of all the potential that exists within the individual so as to make the process of change toward maturity, intelligence and self-maturation. Education is an effort undertaken by families, communities and governments through counseling, teaching and training activities, which take place in school and out of school throughout life to prepare learners in order to play a role in various types of work and in life community. Of course, education is the responsibility of parents to their children and the state against the citizen (Saragih, 2017). Education is a unit of action that encourages the occurrence of learning as well as by learning the physical and mental development of students.

In teaching and learning activities in school, mathematics is an important lesson that is certainly required to be able to be applied in real life students. On the other hand, the function of mathematics is as a medium or means of students in achieving competence. By studying mathematics, students are expected to master a set of competencies that have been established. By the way, the mastery of mathematics is not the ultimate goal of mathematics learning, but the mastery of mathematical is the way to achieve competency control, as well as competence in solving mathematical problems. It is written in NCTM (2000) that problem solving is the process of applying the previously acquired knowledge to new and different situations. Minarni (2017) states that when students are in the process of solving mathematical problems then the student is building other mathematical skills such as the ability of understanding, the ability of mathematical representation, and other ability.

Unfortunately, TIMSS (2015) reports that Indonesian students only get 397 at problem solving which means only 4% of the questions are answered correctly. Indonesia students is placed at rank 46 out of 51 countries And based on PISA 2015, Indonesia scored 389 while standard score is 500 (Mullis, 2007) in mathematical ability. TIMSS and PISA results illustrate that the problem solving abilities of Indonesian students in mathematics involving knowledge, application and reasoning are still very low.

Furthermore, based on the diagnostic test given, it can be concluded that the students of SMP Budi Agung Medan have the ability mathematical problem solving (MPS) in the low category, especially in the second aspect of MPS, that is planning the strategy to attain the solution and at the 4th stage, that is looking back towards the problem posed. This is in accordance with a study entitled "On Eight Grade Students Understanding in Solving Mathematical Problems" (Minarni, 2017), which states that, on the aspect of determining mathematical models, students can do well, and students face difficulties in planning aspects of settlement and explaining solution to the proposed problem. In addition, it is mentioned that constructivism based approach/model such as problem-based learning can develop understanding ability and mathematical

representation which is a component of mathematical problem solving ability of junior high school students (Minarni & Napitupulu, 2016). Cooperative learning and contextual learning are also based on constructivism that can be expected to improve cognitive aspects such as problem solving (Arends, 2004).

On the other hand, the use of technology in the learning process, including computer technology and software can improve students' ability in doing mathematics (Agyei & Voogt, J, 2010). However, the use of software that can help the learning activities of mathematics in SMP Budi Agung Medan also not maximal. Meanwhile, in other schools, Information and Communication Technology (ICT) has been used in education since the beginning of the technology discovered, and used heavily since the early 1980s (Becta, 2003). So, the use of Geogebra software is an important thing to be applied in teaching and learning activities. The use of Geogebra is effective for modeling instructional strategies for improvement and change in teacher pedagogy (Escuder and Furner, 2012). Another opinion suggests that students have a positive perception of learning and have better learning achievements using Geogebra (Zengin, 2012). Then, it can be hope that Geogebra-assisted Learning Approach could improve mathematical problem solving ability of the students.

II. Theoretical Framework

According to Bell (1978), the problem for someone is not necessarily a problem for others. Problems can be felt or realized by someone who cares about an interesting phenomenon Problem is something to be solved even though it is complex, has no procedures and requires some strategy to solve it. Meanwhile, problem solving is "the process of applying previously acquired knowledge to new and unfamiliar situations" (Branca, 1980) or problems.

Whenever one include in problem solving, he will follow some steps to attain the solution. Four steps in problem solving proposed by Polya (1987), as follow:

1. Understanding the problem
2. Device a plan
3. Execute the plan
4. Looking back

As an analogy, mathematical problem solving is the process of applying previously acquired mathematical knowledge to new and unfamiliar problems. Through the process of solving math problems, intelligence of the student will become sharp as well as his tenacity.

Geogebra-assisted cooperative learning and geogebra-assisted Contextual learning are learning approach that used Geogebra software as an aid in learning mathematics in order the students more understand the abstract concept of mathematics. Geogebra-assisted learning approach has been successful in improving mathematical-concept understanding of junior high school students (2018). Mathematical concept understanding is an important role in problem solving (Minarni, 2017).

Related to contextual learning, Duff (2012) in his research entitled "Cooperative Learning vs. Direct Instruction: Using Instructional Models to Determine their Impact on Student Learning in a Middle School Math Classroom ", that in general the lessons taught by cooperative learning are more fun and students can connect the material with their own lives.

Research Question

Based on the background of the problem then the question in this study is:

"Are Geogebra assisted cooperative learning approach and contextualized learning approach able to grow students' mathematical problem-solving ability?"

III. Research Methods

This research is categorized quasi experiment, conducted in SMP Budi Agung Medan with all students of class VIII as population and class VIII-4 (experiment I) and VIII-1 (experiment II) as samples. In the experimental class I applied Geogebra assisted cooperative learning, while in the experimental class II applied Geogebra assisted contextual learning. Research design used in this research is *Pretest-Posttest Control Group Design* as presented in Figure 1.

O_1 T_1 O_2
O_1 T_2 O_2

Figure 1

Note: X_1 = Geogebra assisted Cooperative Learning Approach
X_2 = Geogebra assisted Contextual Learning Approach
O_1 = Test 1
O_2 = Test 2 (Post test)

Before the cooperative learning and contextual learning is applied, the teacher first provides a diagnostic test to see students' mathematical prior knowledge (MPK) or Test 1. At the time the learning is implemented, students are given Student Activity Sheets (SAS) to be discussed in groups according to the teacher's instructions. Shared responsibility and recognition of awards in the cooperative learning make the students more motivated in completing the problems in SAS and in the discussion.

The difference of the two approach is Cooperative learning stressed team work in a group along teaching learning activity, while contextual learning give more attention to mathematical problems used in the classroom, problems are designed based on appropriate context, rich context and meaningful.

Data collection techniques in this study using tests to measure students' mathematical problem solving abilities. Data analysis technique used in this research is descriptive and inferential analysis. Descriptive statistical analysis is used to view categories of students' mathematical problem solving abilities based on the problem-solving stage. Inferential statistical techniques are used to test the research hypothesis. Quantitative data to be analyzed in this research is the result of diagnostic test and post test. Data obtained from the scores of problem solving skills of mathematics is grouped based on learning approach (cooperative and contextual).

Data processing begins by testing the necessary statistical prerequisites, namely normality test and homogeneity test. Next, performed ANOVA using the help of computer programs SPSS version 22 and Microsoft Excel program.

IV. Results And Discusion

Result

Data analysis consisted of analysis of mathematical problem solving ability, and analysis of interaction between learning approach and gender to student's mathematical problem solving ability.

Mathematical Prior Knowledge Factor

Mathematical prior knowledge (MPK) is the knowledge that students have before learning takes place. MPK is the foundation for the formation of new concepts in learning. Provision of diagnostic tests is a tool to determine MPK and group them into high, medium, and low categories for use in the division of student discussion groups. The average calculation and standard deviation of MPK are listed in Table 1:

Table 1. Average and Standard Deviation of MPK

Class	Ideal score	N	$\bar{x}$	SD
Geo-assisted Cooperative Learning	100	30	52.80	17.06
Geo-assisted Contextual Learning		30	53.50	16.80

It appears in Table 1 that students MPK in both classes are the same. This shows that students in both experiment classes have a homogeneous mathematical initial ability. Result of MPK difference test is presented in Table 2.

Table 2. Result of MPK Difference Test

Class	N	Variance (s^2)	s^2	t_{count}	Df	t_{table}
Geo-assisted Cooperative Learning	30	291.2	16.9	-0.62	58	2.00
Geo-assisted Contextual Learning	30	282.3				

Based on Table 2 above, it appears that the value of t_{count} is between -2.00 and 2.00, ie $-2.00 \leq -0.62 \leq 2.00$. Thus, Ho is accepted, and it can be concluded that there is no difference between MPK in experimental class I and experimental class II. It means, Geogebra-assisted Learning approach can be implemented in the two homogeneous classroom. So, the students start at the same MPK position.

Mathematical Problem Solving Posttest

Posttest is given to determine students' mathematical problem solving abilities (MPSA) after being treated. The post test description of students' mathematical problem solving abilities is shown in Table 3:

Table 3. Posttest Average and Standard Deviation Score of MPSA

Class	Ideal score	N	$\bar{x}$	SD
Geo-assisted Cooperative Learning	100	30	70.5	11.5
Geo-assisted Contextual Learning		30	76.9	8.5

Table 5 shows that students' mathematical problem-solving abilities in both experimental classes after treatment were found to be homogeneous (not much different) with each high score of 70.47 and 76.93. The classification of mathematical problem solving abilities (MPSA) of students in both experimental classes is presented in Table 4.

Table 4. Classification of Students MPSA Score

No	Interval	Category	Geo-assisted Cooperative Learning		Geo-assisted Contextual Learning	
			N	%	N	%
1	80 ≤ Score ≤ 100	Very good	9	30%	13	43%
2	65 ≤ Score < 80	Good	12	40%	15	50%
3	55 ≤ Score < 65	Adequate	4	13%	2	7%
4	40 ≤ Score < 55	Less (Low)	5	17%	0	0%
5	Score < 40	Very low	0	0%	0	0%

Table 4 shows that there are no students anymore with very low category in both experiment classroom, even no students with low category in Geo-assisted Contextual Learning. Many students has good category in both experiment class. The researcher also interested in investigating the difference of mathematical problem solving ability (MPSA) based on gender. Students MPSA based on gender is presented in Table 5.

Table 5. Students MPSA based on Gender

Class	Gender	N	Average score
Experiment I	Boy	16	66.3
	Girl	14	75.0
Experiment II	Boy	15	77.8
	Girl	15	76.0

Table 5 explains that in the experimental class I, female students (boy) are superior to male students (girl) in mathematical problem solving ability, whereas in the experimental class II the opposite is applied. So, it is interesting to investigage interaction between Geogebra-assisted learning approach and gender towards MPSA of the students.

The following table descibe average posttest score at each MPSA aspect (category).

Table 6. Average Posttes score based on Each MPSA Aspect

Aspect	Experiment I	Experiment II
Understanding the problem	3.74	3.87
Plan the strategy	3.21	3.47
Execute the strategy	2.73	2.94
Looking back	1.58	2.03

Testing Hypothese

The first hypothesis is that there is a difference of MPSA among students in experimental I with students in experiment II. The test criteria for testing the hypothesis is if the significance <0.05 (sig. <0.05) then reject Ho and if significance> 0.05 (sig.> 0.05) then reject Ha. The results of the first hypothesis test with Two Path ANOVA test using SPSS Program is described in Table 7.

Table 7. Result of Hypothese 1 and 3 Test

Tests of Between-Subjects Effects					
Dependent Variable:MPSA					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1206.401[a]	3	402.134	4.217	.009
Intercept	326446.608	1	326446.608	3.423E3	.000
Gender	178.171	1	178.171	1.868	.177
Learning Approach	571.401	1	571.401	5.992	.018
Gender * Learning Approach	402.153	1	402.153	4.217	.045
Error	5340.199	56	95.361		
Total	332448.000	60			
Corrected Total	6546.600	59			
a. R Squared = .184 (Adjusted R Squared = .141)					

Based on Table 7, it can be seen that the significance value for the learning approach is 0.018 (sig. <0.05), which means that there is a significant difference between the average of mathematical problem solving abilities between students taught through Geogebra assisted cooperative learning and students who learn through Geogebra assisted contextual learning approach.

Significance level for the gender * learning approach is 0.045 (sig. <0.05), thus reject Ho and accept Ha. This indicates that there is interaction between Geogebra assisted learning approach (cooperative and contextual) and student's gender toward student's MPSA. It can also be described in the following figure.

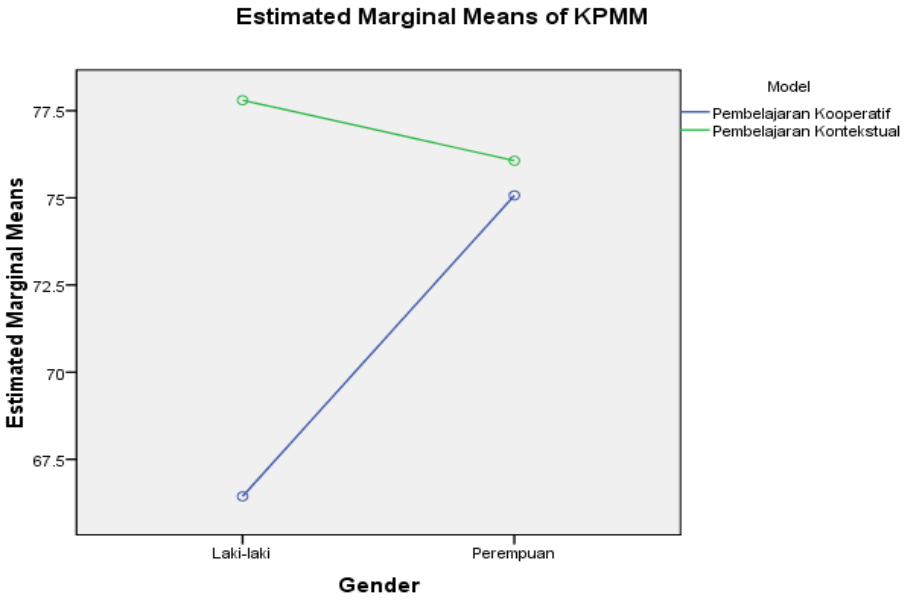

Figure 1. Students MPSA based on Learning Approach and Gender

Graph of students MPSA base on learning approach and gender shows the existence of interaction. Interaction is the joint influence of two independent variables or more to the dependent variable. Kerlinger (1986) states that "interaction occurs when an independent variable has different effects on a variable bound to various levels of another independent variable". In this research, interaction is the joint influence between the learning approach (cooperative and contextual) with gender to students' MPSA.

Based on the results of descriptive analysis of students' mathematical problem solving abilities, it was found that male students in experimental class I get average score of 66.31 and female students get average score of 75.00. This shows that the mathematical problem solving ability of male students is lower than female students for experimental class I. While male students in experiment class II get average score of 77.79 and female students get average score of 76.02. Thus, it can be stated that the mathematical problem solving ability of male students is higher than that of female students for experimental class II.

Based on the results of inferential statistical analysis with two-path ANOVA test on the gender row*learning approach obtained sig.0.045 (sig. <0.05), it can be concluded that there is interaction between Geogebra-assisted learning approach (cooperative and contextual) with gender to the MPSA of the students. This is in accordance with the study of Murtafiah and Amin (2018) in his research entitled "The Influence of Cognitive Style and Gender on Mathematical Problem Solving" that the cognitive and gender styles together significantly influence the students' math problem solving ability.

Further research result is the classification of students MPSA. Based on the results of research that has been done, the criteria of students' mathematical problem solving ability at each aspect of MPSA can be described as in Table 8.

Table 8. Average Score of MPSA Test at Each Aspect

Aspect	Experiment I			Experiment II		
	$\bar{X}$	%	Kriteria	$\bar{X}$	%	Kriteria
Understand the problem	3.74	93.50	Very good	3.87	96.75	Very good
Plan the strategy	3.21	80.25	Good	3.47	86.75	Good
Execute the strategy	2.73	68.25	Enough	2.94	73.50	Enough
Looking back	1.58	39.50	Less (Low)	2.03	50.75	Less (Low)
Total	2.88	70.38	-	3.09	76.94	-

Based on the data in Table 8, it appears that the ability of solving mathematical problems in both experiment class includes in good category (see Table 4), that is 70.38 for experiment class I and 79.94 for experiment class II. This shows that both types of constructivism-based learning that is cooperative learning and contextual learning approach can grow student's mathematical problem solving ability. Based on Table 4, students MPSA achievement at both experiment classroom belong to good category.

Analysis of Test Result

The cooperative learning approach can foster the ability to solve mathematical problems because this lesson emphasizes joint attitudes / behaviors in working or helping among others in a regular group structure of cooperation, consisting of 2 or more persons to solve problems, prioritizes cooperation in solving problems to apply knowledge and skills in order to achieve learning objectives so that students' academic learning results are increasing and students can receive a variety of diversity from their friends, as well as gain the development of social skills.

This is supported by Vygotsky's theory of learning which focuses more attention on the relationship of dialectics between individuals and society in the formation of such knowledge. It focuses on the sociocultural aspects of learning, namely social interaction through dialogue and verbal communication with adults. Because there is a mutual influence between language and action in social conditions (Slavin, 2006). Vygotsky considers that language is central to the learning process (Oakley, 2004). The existence of social interaction with peers or even with the teacher, will affect the communication skills of students in learning. Thus, the existence of social interaction among students in a group or with other groups and shared responsibilities in groups and equipped with teachers who act as motivators, facilitators and moderators will enable more qualified discussion and more effective learning.

In addition, Ausubel's meaningful learning theory and constructivism learning theory is also a theory that reinforces cooperative learning approach. The theory of constructivism study considers that in the process of teaching and learning, the acquisition of knowledge begins with the occurrence of cognitive conflict (Bell, 1978). This cognitive conflict can only be overcome through self-regulation. At the end of the learning process, knowledge will be built by the child through his experience of interaction with his environment. Ausubel's meaningful learning theory emphasizes the importance of students associating new experiences, phenomena, and facts into their cognitive structures. Both emphasize the importance of assimilating experience into the cognitive structure and emphasizing that the learning process is by way of active students.

Other learning approach used in this research is contextual learning emphasizes the full process of student involvement in order to discover the material learned and relate it to real life situations, thus encouraging students to apply it in their lives. Contextual learning is closely related to daily life (personal, social, and cultural context) so that students have knowledge/skills that can be flexibly applied from one problem to another. Thus, learning outcomes are expected to be more meaningful for students. The learning process takes place more naturally in the form of Student activity sheet and experiencing, not the transfer of knowledge from teacher to student alone. Therefore, the role of the teacher is not only as a transmitter of information but also as a facilitator, mediator, and as a companion as well as colleagues students in finding knowledge.

Contextual learning with its components is a learning that supported by many learning theories. Contructivism theory, which emphasizes the importance of students building their own knowledge, Dewey's learning theory about the importance of questions and reflection in learning. Piaget's theory of learning is of paramount importance of authentic judgment and learning by discovering the students' own knowledge during the learning process, Ausubel's learning theory which emphasizes the importance of meaningful learning, Bruner's learning theory which also raises the importance of discovery learning, Vygotsky's learning theories, Piaget and Bruner on the importance of learning in groups.

Contextual learning in this research give positive influence to MPSA since MPSA is improved after implementing this learning. It is in accordance with a statement from Duff (2012) in his research entitled "Cooperative Learning vs. Direct Instruction: Using Instructional Models to Determine their Impact on Student Learning in a Middle School Math Classroom ", that in general the lessons taught by cooperative learning are more fun and students can connect the material with their own lives. Teaching and learning activities during the middle of learning and practice tests also reflect students' learning environments on cooperative learning more allowing students to get a chance to understand the material learned.

In this study, the two learning approach supported by ICT, that is with Geogebra software. This certainly has a contribution in supporting the effectiveness of learning. This is in accordance with the research of Arbain and Shukor (2015) entitled "The effects of Geogebra on students achievement" which examines the effectiveness of learning using Geogebra software on Mathematics learning on 62 students in Malaysia. This research shows that students have positive perceptions of learning and achievement, learn better by using Geogebra. In addition, Saha (2010) in his research entitled "The Effects of Geogebra on Mathematics Achievement: Enlightening Coordinate Geometry Learning", stated that based on independent t-sample test results showed that there was a significant difference on the average mathematical achievement between Geogebra group and traditional learning strategy group. Tomljenovic and Zovco (2016) in his research entitled "The Use of ICT in Teaching Mathematics - A Comparative Analysis of the Success of 7th Grade Primary School Students" stated that from a written test conducted, the mathematical completion rate of linear function in ICT-based mathematics classes significantly higher, so the use of ICT in mathematics learning leads to better learning.

Thus, the growth of mathematical problem-solving ability after the application of Geogebra assisted cooperative learning and Geogebra-assisted contextual learning obtained in this research is in line with the studies that have been conducted by other researchers.

Classroom Activity

Grouws (1992) states that "problem solving in learning mathematics is an attempt to find solutions of a situation faced so as to achieve the desired goals". Problem solving as an approach in learning is used to discover and understand mathematical material or concepts. While as a goal in learning, is the ability to be achieved students. Therefore, the ability to solve mathematical problems is one of the most important skills to be mastered by students.

Based on the results of data analysis descriptively before being treated, students in both classes have a mathematical problem-solving ability that does not differ significantly and categorize low. This can be seen from the average diagnostic test score of experimental class I and experiment II are 52.71 and 53.49 respectively. After being treated, the ability of problem solving of the students who learn with Geogebra-assisted contextual learning is higher than students studying with Geogebra-assisted cooperative learning. This is indicated by the average posttest score of experimental class I is 70.47, while in the second experiment class is 76.93.

Based on the above explanation, it can be concluded that there is difference of mathematical problem solving ability of the student which learn through cooperative learning and contextual instructional with aided by Geogebra software. This is in line with Efil (2018) statement in her research that Geogebra-assisted learning approach could improve students conceptual mathematics as a pondation mathematical problem solving ability.

At the beginning of the first lesson, teaching and learning activities in the experimental class I were more quickly responded and adapted by the students compared to the experimental class II. This is possible because teachers 'involvement in learning in experimental class I is more dominant when compared to experiment class II which focuses on students' active activity in finding and processing information. Gradually, students' ability to understand problems, plan solutions, perform calculations and confirm in learning activities and in doing LAS is more likely to be seen understood by students in experimental class II. This is possible because of the inquiry activity in the contextual learning that makes learning more meaningful and more embedded in the students' memory for a longer period of time. Mathematical thinking in solving problems consists of three levels called empirical activity (informal), algorithmic (formal) and constructive (creative)". In the first level, various techniques or practical applications of mathematical rules and procedures are used to solve problems without a certain consciousness, so it is still in trial and error. In the second level, mathematical techniques are used explicitly for operations, counting, manipulation and problem solving. While at the third level, non-algorithmic decision-making is demonstrated in solving non-routine problems such as a matter of discovery and construction of some rules.

The interdependence among students in the group made interactive discussions and exciting exchanging ideas between students in the group. In addition, the accumulation and awards announcement at the end of cooperative learning makes the students in the group more motivated in solving the problems. However, in experiment class II, the questioning and modeling activities in the contextual learning can improve students'

understanding towards mathematical concept being studied. In this case, students are less active in competing, they are only involved in questioning on things they do not understand. The students' understanding is even better with the modeling activities that present the model as an actual example. While, mathematical understanding ability underpin mathematical problem solving ability (Minarni, 2017). So, the students get benefit from meaningful learning activities, especially in learning mathematics.

V. **Conclusion**

Based on the results of data analysis on the ability of mathematical problem solving, the researchers obtained some conclusions as follows:

1. There is a difference of mathematical problem solving ability between the students who learn through Geogebra-assisted cooperative learning and Geogebra-assisted contextual learning approach.
2. There is an interaction between learning approach and gender to students' mathematical problem solving ability.
3. Mathematical problem solving ability of the students at both experiment class included in "good" category.

VI. Suggestion

Based on the conclusions that have been described above, the authors proposed some suggestions as follows:

1. Teacher shoul uses Cooperative learning as an alternative in teaching and learning activities to maximize students' mathematical problem solving ability especially for female students. While, the contextual learning should be used as an alternative in teaching and learning activities to maximize students' mathematical problem solving skills, especially for male students.
2. Teachers are expected to improve paedagogic skills and add insight into innovative learning approach and integrate ICT in learning.
3. The next researcher should undertake further research with more samples and include several schools in several different areas.
4. The researcher should then examine other variables such as reasoning and communication, mathematical connections, mathematical communication, and mathematical understanding itself.

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Doni Irawan Saragih "Analysis of Eight Grade Students' Mathematical Problem Solving Ability based on Geogebra-assisted Learning Approach." IOSR Journal of Research & Method in Education (IOSR-JRME) , vol. 8, no. 4, 2018, pp. 64-72.