The Aplication of Geogebra in Mathematical Problem Solving and Problem Posing of Prospective Teacher

Ipah Muzdalipah [1)], Eko Yulianto[2)]

[1)]*Mathematics Education Study Program of FKIP, University of Siliwangi, Indonesia*
E-mail: ipah.muzdalipah@gmail.com

Abstract: Ideally, Mathematical skills of prospective teachers not only focus on problem-solving, but needs to be sharpened to the ability of constructing a problem. It has become very important, especially for prospective teachers who would use technology in appropriate model. This study used the software of GeoGebra in prospective teachers' problem solving and problem posing. The prospective teachers were students in fifth semester of mathematics department of education Siliwangi University. The results show that there is significant influence of GeoGebra to the problem solving and problem posing ability in geometry-vector of prospective teachers. There are significant differences between problem solving and problem posing in GeoGebra assisted learning. There are significant differences between problem solving and problem posing in conventional learning. Learning Satisfaction of prospective teachers through assisted learning GeoGebra relatively positive. The most problem of prospective teachers was in posing problem because they rarely get treatment construct problems.

Keywords: Problem Posing Approach, GeoGebra, Mathematics Problem Solving, and Problem Posing and Learning Satisfaction

I. INTRODUCTION

The education development increasingly rapid requires teachers and prospective teachers to have a qualified competences. According to the constitution number 14 in 2005, teacher is a professional job that can only be done by someone who has academic qualifications, competences, and educator certificate. Therefore, creating a good prosepctive teacher the firts step of solutions for improving the quality of education.

Competence is the description of the quality of person's behavior and a skill that can be shown and measured. For prospective teachers of mathematics, academic competence related to the pedagogical content knowledge of mathematics, and it was identified as a real contributor of teachers' role in mathematics teaching. Pedagogical content knowledge positively correlated to the subject matter knowledge, the better teachers' subject matter knowledge, the better teachers' pedagogical content knowledge (Yulianto, 2015).

Subject Matter knowlege represents knowledge in the material master mathematics teacher both the concept and mathematical problems. This is supported by the NCTM (2000: 2) who proposed 'one of the important components of mathematics skill is the understanding of concept'. While one purpose of mathematics teaching and learning in primary and secondary school is to make students' understanding of mathematical concepts, explain the link between concepts, applying the concept in flexible, accurate, efficient and precise. Therefore, besides being able to solve mathematical problems, prospective teachers must be able to construct an issue of mathematics concepts into context are weighted so that the learning more meaningful.

In the NCTM (2000: 2) there are six fundamental principles for high-quality mathematics instruction. The six principles are equity, curriculum, teaching, learning, assessment, and technology. The media of the six principles included in the sixth principle, namely technology. With the help of the media will be able to help the students' understanding of mathematics in order to achieve a quality education. Certainly, to create teaching and learning technology, prospective teachers must be mastery in the technology.

Two hundred years ago a teacher only needs to know and understand the content of material as determined by a certain grade level they teach (Niess, 2009 : 511). The conviction of today about what you need to be known by teachers has really changed based on technology development and teacher preparation programs. For example, Shulman (1986 : 9) were eager to know, 'how do teachers decide what to teach, how to represent, how the students questions about it, and how to deal with the problem of misunderstanding?'. Therefore, Shulman and his colleagues built a theoretical framework of *pedagogical content knowledge* (PCK) which has become an effective framework to analyze the knowledge of teachers and teacher preparation programs.

Koehler dan Mishra (2005 : 3) proposed a new concept of framework Technological Pedagogical and Content Knowledge (TPACK), which theoretically integrate technology into the system of teacher knowledge which is based on a framework Shulman and presents a way of thinking about the essential knowledge that must be held by teachers to teach effectively with technology and how they develop such knowledge. One computer program which can be used as a medium of learning mathematics, especially geometry is GeoGebra. According to Hohenwarter (2008 : 5), 'GeoGebra is a computer program (software) for the study of mathematics, especially geometry and algebra'.

Researchers interested in conducting research on the

development of prospective teachers learning tools to be applied in the subject of vector analysis on topics relating to the application of geometry. In addition to learn the software as a training vessel, this research is also important to measure the extent to which prospective teachers are ready to apply technology in learning. The purpose of this study was to see the effect of GeoGebra to construct problem-solving ability and geometry-vector of mathematics prospective teacher and to compare the ability of problem solving and problem posing with the help of GeoGebra and conventional learning.

Many researchers believe that there are a number of great opportunities that are possible with the technology to promote the acquisition of concepts quickly and easily (Hitt, 2011 : 724). Specifically NCTM (2000 : 0033) said 'technology is essential in teaching and learning mathematics, it affects the mathematics that is taught and enhance students' learning activities'.

21st century technology is centered on the computer. In this computer environment a lot of different software attempts to integrate into the education of mathematics, such as *Dynamic Geometry Environments* (DGEs), *Computer Algebra System* (CAS), *spreadsheet*, graphing calculators, statistical packages and software charts. When the need to deal with mathematical equations symbolically, they use the CAS that allows rapid manipulation and calculation algebra routines. The main objective of the CAS is to automate tasks algebraic manipulation tedious and sometimes difficult.

Although the capabilities of the software used in mathematics education and growing rapidly, but their progress is not fast enough as desired and they are mainly used for drill and practice on the topics that were previously developed in class (Niess *et al.,* 2009). In addition to the importance of the integration of technology in education, necessary prudence in the implementation when using it. A balanced implementation necessary for successful teaching between the use of technology and traditional methods such as paper-pencil activities (Hitt, 2011).

Faced with the challenge of how teachers can integrate technology into their teaching and approaches required for teaching as an interaction between what is known to teachers and how to apply them in unique circumstances or context in their classroom. There is no "one best way" to integrate technology into the curriculum. Instead, efforts should be creative integration designed or structured to ideas of certain subjects in the context of a particular class.

There are various ways in which the candidates familiarize teachers teaching mathematics with technology, including a computer can be used as a tool of the learning process as well as the media to help ensure a concept. In most cases the learning of mathematics, mathematical software is more widely used as a medium to help prove the concept. According to Hohenwarter (2008 : 1), GeoGebra is very useful program for teachers and students. GeoGebra can be installed on a personal computer and used anytime and anywhere by students and teachers. According to Kusumah (Budhiawan, 2012:28), 'computer programs are ideal to be used in learning mathematical concepts that require high accuracy, concept or principle that repetitive, settlement charts accurately, quickly, and accurately'. Furthermore Kusumah (Budhiawan, 2012) also suggested that computer-assisted learning innovation is very good to be integrated in learning mathematical concepts, especially concerning the transformation geometry, calculus, statistics, and graphics functions. One computer program which can be used as a medium of learning mathematics is a program GeoGebra.

Based on some understanding of the above, it can be concluded the understanding of learning mathematics by using GeoGebra is the efforts of teachers in creating an attractive learning environment by utilizing the GeoGebra program so that students can be actively involved to understand the concepts and principles of mathematics. The media as a tool in the teaching-learning process is a reality that can not be denied. Even though, Djamarah (2006) explained that the use of media as tools can not arbitrarily arbitrarily according to the teacher,but must pay attention to and consider the goals.

TABLE I
FONT SIZES FOR PAPERS

Font Size	**Appearance (in Time New Roman or Times)**		
	Regular	**Bold**	**Italic**
8	table caption (in Small Caps), figure caption, reference item		reference item (partial)
9	author email address (in Courier), cell in a table	abstract body	abstract heading (also in Bold)
10	level-1 heading (in Small Caps), paragraph		level-2 heading, level-3 heading, author affiliation
12	author name		
18	Title		

II. METHODS

The method used in this research was quantitative research. This study aimed to look at the effect of using software goegebra to construct problem-solving ability and geometry-vector math teacher candidate as well as comparing the ability of the class with GeoGebra assisted learning and conventional learning.

The population in this study were all students of Mathematics Education Siliwangi University in Tasikmalaya in academic year of 2015-2016 were taking courses in vector analysis as much as three classes a number of 124 people. Sampling was choosen by random and class C-E was selected as a control group were 51 people and class D-F as the experimental class each as much as 41 people. In mid-lecture, 4 prospective teachers of grade control is inactive and therefore not as research subjects. In other words, the control class is composed of 47 people.

There were two instruments used for this research, test questions and questionnaires. About the tests used to measure problem-solving skills-vector geometry as much as 4 matter and measure the ability to construct vector geometry application problems as much as 4 matter. Problems were made through discussions four lecturers who teach vector analysis and is based on the level of difficulty from the viewpoint of the material requisites. Prior to use, the instruments were tested empirically in a sample of

students outside to see the validity and reliability of the instrument items, in this case the instruments tested by a 7th semester student who has contracted previously subjects of vector analysis. Feasibility instruments were also validated through the judgment by 2 lecturers and 2 lecturers geometry vector. While the questionnaire is only validated by expert faculty of judgment alone.

III. Result and Discussion

Based on the results of data analysis of the first hypothesis with Mann Whitney U-Test through SPSS 22., obtained the following results:

TABLE 1.
Mann Whitney U-Test
Ranks and Test Statistics[a]

Kemampuan	kelompok	N	Mean Rank	Sum of Ranks
Pemecahan dan Mengonstruksi Masalah	Eksperimen	41	52.99	2172.50
	Kontrol	47	37.10	1743.50
	Total	88		
Mann-Whitney U				811.500
Wilcoxon W				1743.500
Z				-2.912
Asymp. Sig. (2-tailed)				.004

a. Grouping Variable: Kelompok

Based on the above table it is known that Asymp. Sig (2-tailed) of 0.004 <0.05, then in accordance with the basis for a decision in the Mann-Whitney test can be concluded that H_o is rejected. The rejection of the H_o implies that there is significant influence of the use of GeoGebra towards solving abilities and construct geometry-vector math teacher candidates.

Based on the analysis of second hypothesis with the Wilcoxon-Test. Through the help of SPSS 22, obtained the following results:

TABLE 2.
Wilcoxon Test
Ranks and Test Statistics[a]

		N	Mean Rank	Sum of Ranks
Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah - Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum	Negative Ranks	0[b]	.00	.00
	Positive Ranks	41[c]	21.00	861.00
	Ties	0[d]		
	Total	41		
Z				-5.620[e]
Asymp. Sig. (2-tailed)				.000

a. Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah < Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum
b. Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah > Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum
c. Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah = Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum
d. Wilcoxon Signed Ranks Test
e. Based on negative ranks.

Based on the above table it is known that Asymp. Sig (2-tailed) 0.000 <0.05, then in accordance with the basis for a decision in the Wilcoxon test can be concluded that H_o is rejected. The rejection of the H_o implies that there are significant differences between problem solving ability and geometry-vector construct prospective teachers of mathematics learning by using GeoGebra.

Based on the results of data analysis third hypothesis with Wilcoxon-Test. Through the help of SPSS 22, obtained the following results:

TABLE 3.
Wilcoxon Test
Ranks and Test Statistics[a]

		N	Mean Rank	Sum of Ranks
Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah - Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum	Negative Ranks	0[b]	.00	.00
	Positive Ranks	47[c]	24.00	1128.00
	Ties	0[d]		
	Total	47		
Z				-5.917[e]
Asymp. Sig. (2-tailed)				.000

a. Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah < Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum
b. Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah > Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum
c. Kemampuan Pemecahan dan Mengonstruksi Masalah Setelah = Kemampuan Pemecahan dan Mengonstruksi Masalah Sebelum
d. Wilcoxon Signed Ranks Test
e. Based on negative ranks.

Based on the above table it is known that Asymp. Sig (2-tailed) 0.000 <0.05, then in accordance with the basis for a decision in the Wilcoxon test can be concluded that H_o is rejected. The rejection of the H_o implies that there is a difference between problem solving ability and geometry-vector construct prospective teachers of mathematics in conventional learning.

Satisfaction of learning to be part of the question of the study. The results of questionnaire obtained the following data:

TABLE 4.
RESULTS SATISFACTION STUDY PROSPECTIVE TEACHERS OF MATHEMATICS

No.	Dimension	Indicator	Mean (Scale of 1-4)	Percentage (%)
1.	Satisfaction of Understanding Matter	Invented the concept by-self	3,35	84
		Feel the benefits of the material being studied	3,15	79
		Applying problem-solving	3,02	76
		Inspired constructs problem	3,11	78
2.	Satisfaction of Learning Model Application	The accuracy of the model applied with the material being studied	3,05	76
		Conformity time required	3,16	79
		Availability carrying means with the model used	3,01	75
		lecturer Feedback	3,12	78
3.	Satisfaction of tasks study	Counseling services and structured tasks independently	3,11	78
		Difficulty index and the availability of reference	3,07	77
4.	Satisfaction of assessment	Fairness assessment	2,99	75
		Conformity assessment with learning contract	3,10	77
Mean			3,10	77,6%

Based on the data above shows that prospective teachers have a positive learning satisfaction with a percentage of 77.6%.

Discussion of the results of research carried out based on the variables examined in this study. These variables include learning model that uses GeoGebra and conventional, construct problem solving ability and geometry-vector candidate math teacher, math teacher candidates studying satisfaction and learning obstacles by using GeoGebra.

1. Model Learning by Using GeoGebra and Conventional

Compared with conventional learning models, learning with the help of GeoGebra show a meaningful role in improving and constructing problem-solving ability-vector geometry math teacher candidates. Conventional learning, lecturers teaching model posing problem purely through strategies that can improve problem solving capabilities and construct but without the tools. One strategy used to stimulate students to build the question then discuss and seek solutions independently. Premises routines, this method can create critical thinking and spark curiosity. In the experimental class with the same model but involves assistance in learning GeoGebra.

Based on the results of data analysis show that there are differences and construct problem solving skills in prospective teachers in the experimental class and control class. In a class with conventional learning, problem posing models can work well with the many techniques of scaffolding. This is done when potential confusion teacher asked a question, the lecturers provide more in-depth illustrations or even if necessary the lecturer gives examples of questions that may be made. In the experimental class lecturers to do the same technique when prospective teachers have barriers in asking questions, it's just scaffolding techniques are given not by example but to give direction to the prospective teachers to work with the software GeoGebra. In other words, there is a difference scaffolding techniques given a lecturer in both classes.

In terms of allocation of learning, both classes have a very clear distinction that the conventional class allocation 3sks highly enough to come to the question of enrichment. While the experimental class cederung tight, almost every form of matter enrichment meetings always race against time. This happens because the learning is not done cooperatively so that each person working alone to finish the job.

In terms of the learning experience, both classes have different responses so far. The experimental class every prospective teachers ask questions that vary even they tend to be surprised when they already know the formula new turns them knowing their applications through the use of GeoGebra. In other words, the learning experience in the classroom using GeoGebra can be said more significant than in the control class.

The above descriptions give enough support to the data overview and data analysis statistically that there is significant influence from the use GeoGebra to construct problem-solving ability and geometry-vector math teacher candidates.

One of the advantages of learning a perceived problem posing researchers are students more responsible in solving the problem. This is evident from the enthusiasm of students to achieve the solution of the questions are very high. The author identifies that this happens because of problems that appear to originate from the students themselves.

2. Problem Solving and Problem Posing Abillity

Problem solving skills reflect the ability of prospective teachers in providing solutions systematically from non-routine issues covering the steps of identifying problems, planning the work, perform calculations and check back in a matter of contextual answers. The ability to construct an issue mencrminkan skills of prospective teachers of mathematics in making geomteri application problems whose solutions are not routinely required vector concepts are contextual and logical solution to be done using tools GeoGebra.

Based on the test results and construct problem solving prospective teachers in the experimental class that is obtained with the help of GeoGebra learning, show a significant effect compared to students with conventional learning. Learning mathematics through problem posing assist students in foster curiosity by asking questions specific to the subject matter, the difference in the experimental class teacher candidates GeoGebra assisted in constructing the solution or the problem. This is explained by the factors in the previous point.

PROBLEM SOLVING AND PROBLEM POSING IN EXPERIMENT CLASS

Hypothesis testing results indicate that there are significant differences between the problem solving and the ability to construct an issue on prospective teachers in the experimental class. This hypothesis was tested by comparing the average of the two samples that are interconnected so that we can see which is higher than the average. On average problem-solving abilities in the experimental class at 35.12 with a maximum score of 112 and a minimum score of 0. While the average ability of constructing a problem in the experimental class score of 30.12 with the same maximum and minimum. That is problem solving skills teacher candidates is higher than the capability of constructing the problem.

This is explained by the focus groups and in-depth interviews that prospective teachers have more trained than constructing problem solving. Working with problem solving is not foreign for prospective teachers, but the work of constructing the problem remains foreign to the perceptions of prospective teachers. Through work on GeoGebra prospective teachers could be done through an experiment in constructing a problem even in problem solving.

PROBLEM SOLVING AND PROBLEM POSING IN CONTROL CLASS

Hypothesis testing results indicate that there are significant differences between the problem solving and the ability to construct an issue on prospective teachers in the control class. This hypothesis was tested by comparing the average of the two samples that are interconnected so that we can see which is higher than the average. On average

problem-solving abilities in the experimental class at 27.49 with a maximum score of 112 and a minimum score of 0. While the average ability of constructing a problem in the experimental class score of 22.6 with the same maximum and minimum. That is problem solving skills teacher candidates is higher than the capability of constructing the problem.

This condition is similar to the conditions that occur in the experimental class that better problem-solving abilities of the constructing problem. The results of further observations also showed the same reason for prospective teachers is more accustomed to working with problem solving rather than constructing problem.

3. Satisfaction Study on Learning with GeoGebra Help

The first dimension is measured from the satisfaction questionnaire prospective teachers learn through study with the help of GeoGebra is satisfaction in understanding the material. The first dimension shows the average score of 3.16 on a scale of 1-4, it means the satisfaction of prospective teachers in understanding the material through this model by 79%. This dimension is measured through the following four indicators:

The first indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is satisfaction in finding their own mathematical concepts. The average results of the questionnaire showed 3.35 on a scale of 1-4, it means the satisfaction of prospective teachers in finding mathematical concepts through this learning model by 84%. These conditions correspond to the learning process that shows that prospective teachers enthusiastic about working with GeoGebra.

The second indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is satisfaction in feeling the usefulness of learning. The average results of the questionnaire showed a 3.15 out of a scale of 1-4, meaning that prospective teachers satisfaction in feeling the usefulness of this learning by 79%. It can be seen that through the help of GeoGebra construct problem-solving ability and teacher candidates better than the control class.

A third indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is the satisfaction of solving the problem. The average results of the questionnaire showed figures of 3.02 out of a scale of 1-4, meaning that prospective teachers satisfaction in feeling the usefulness of this learning by 76%. While the four indicators used to measure the satisfaction of learning to learning with the help of GeoGebra is the satisfaction of constructing problem. The average results of the questionnaire showed figures of 3.11 out of a scale of 1-4, meaning that prospective teachers satisfaction in feeling the usefulness of this learning by 78%. It can be seen that through the help of GeoGebra construct problem-solving ability and teacher candidates better than the control class.

The third and fourth indicators also showed that prospective teachers learn contentment in constructing bigger problems than in solving the problem, it means learning with the help of GeoGebra greatly assist teachers in developing the thinking process.

The second dimension is measured from the satisfaction questionnaire prospective teachers learn through study with the help of GeoGebra is satisfaction with the learning model. The second dimension shows the average score of 3.09 on a scale of 1-4, it means the satisfaction of prospective teachers in understanding the material through this model by 77%. This dimension is measured by indicators of all 5 to 8 as follows:

The fifth indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is satisfaction with the accuracy of the model with the material being studied. The average results of the questionnaire showed a 3.05 out of a scale of 1-4, it means the satisfaction of prospective teachers on the model accuracy with the material studied in this study amounted to 76%.

Six indicators used to measure the satisfaction of learning to learning with the help of GeoGebra is the effectiveness of the time in this study. The average results of the questionnaire showed figures of 3.16 out of a scale of 1-4, it means the satisfaction of the effectiveness of prospective teachers in the learning time by 79%.

The seventh indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is the satisfaction of the demands of the model with the availability of facilities. The average results of the questionnaire showed figures of 3.01 out of a scale of 1-4, it means the satisfaction of prospective teachers on demand models with the availability of this study was 75%.

The seventh indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is the satisfaction of faculty feedback. The average results of the questionnaire showed figures of 3.12 out of a scale of 1-4, it means the satisfaction of prospective teachers on faculty feedback on this learning by 78%.

The third dimension is measured from the satisfaction questionnaire prospective teachers learn through study with the help of GeoGebra is satisfaction with the learning task. The third dimension shows the average score of 3.09 on a scale of 1-4, it means the satisfaction of prospective teachers in understanding the material through this model by 77%. The task given the task of learning this form of structured and independent assignment that emphasizes on the ability of prospective teachers suckle from a logical algorithms solving geometry problems. This dimension is also measured considering the service, the relevance and references are provided so that the task of allowing it to be done. This dimension is measured by indicators of the 9th and 10th as follows:

Ninth indicators used to measure the satisfaction of learning to learning with the help of GeoGebra is the satisfaction with the services and guidance of the lecturer. The average results of the questionnaire showed figures of 3.11 out of a scale of 1-4, it means the satisfaction of prospective teachers on duty in this model by 78%.

The ten indicators used to measure the satisfaction of learning to learning with the help of GeoGebra is satisfaction with the tasks given to the relevance and references available. The average results of the questionnaire showed 3.07 on a scale of 1-4, it means the satisfaction of prospective teachers on duty in this model by 77%.

The fourth dimension is measured from the satisfaction questionnaire prospective teachers learn through study with the help of GeoGebra is the satisfaction ratings. The fourth dimension shows the average score of 3.04 on a scale of 1-4, it means the satisfaction of prospective teachers in understanding the material through this model by 76%. This dimension is measured by indicators of the 11th and 12th as follows:

The ten indicators used to measure the satisfaction of learning to learning with the help of GeoGebra is the justice system as perceived by the student assessment. The average results of the questionnaire showed 2.99 on a scale of 1-4, it means the satisfaction of prospective teachers on assessment in this study amounted to 75%.

Eleventh indicator used to measure the satisfaction of learning to learning with the help of GeoGebra is conformity assessment with learning contract. The average results of the questionnaire showed 3,10` on a scale of 1-4, it means the satisfaction of prospective teachers on assessment in this study amounted to 81%.

4. Learning Obstacle of Problem Posing Model Assisted GeoGebra

n terms of problem-solving ability and construct, learning through the help of GeoGebra can be said to be effective either because statistics show a significant influence and based on observations in the learning process. The constraints faced by prospective teachers in learning in this study include the availability of a laptop. Some prospective teachers still do not have a laptop and some are there who use a PC so it is difficult for mobility tasks.

Constraints in terms of mathematical ability is that prospective teachers are still not familiar with constructing a problem as is the case when working with troubleshooting. Based on the interview that their experiences during the previous semester are more accustomed to working mainly trained in troubleshooting routine matter.

IV. CONCLUSIONS

Based on the results of data processing research are: There is a significant influence on the use of GeoGebra towards solving abilities and construct geometry-vector math teacher candidates. There are significant differences between problem solving ability and geometry-vector construct prospective teachers of mathematics learning by using GeoGebra;

There are differences between problem solving ability and construct the geometry of the candidate vector math teacher at conventional study. Satisfaction learn math teacher candidates showed positive signs towards learning by using GeoGebra to achieve 77.6% mainly on its impact on the ability of constructing problem-vector geometry.

Some prospective teachers, the limited access to the computer when chores at home. Moreover, they tend to be unfamiliar with job-vector constructs geometry problems. Most of them admit that they are more familiar than constructing trained troubleshoot problems.

ACKNOWLEDGMENT

Thanks to the institute of research and community service commite of siliwangi university who has provided funding for this study.

REFERENCES

[1] Yulianto, Eko. (2015). The Analysis of *Pedagogical Content Knowledge of Secondary School Teacher in Mathematics Teaching.* Prosiding International Seminar on Teachers Education. Dipublikasikan di Riau.

[2] NCTM. (2000). *Principles and Standards for School Mathematics*. USA

[3] Niess, M. L. (2009). Mathematics Teacher TPACK Standards and Revising Teacher Preparation. In L. Paditz & A. Rogerson (Eds.), 10th International conference "Models in Developing Mathematics Education" (pp. 445–449). Dresden. [Online]. Tersedia di: http://math.unipa.it/~grim/21project.htm. Diakses 24 Oktober 20014.

[4] Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*, 4-14.

[5] Koehler, M.J., & Mishra, P. (2005). Teachers learning technology by design. *Journal of Computing in Teacher Education*, 21(3), 94–102.

[6] Hohenwarter, M., et al. 2008. Teaching and Learning Calculus with Free Dynamic Matgematics Software GeoGebra. Tersedia: http://www.publications.uni.lu/ record/ 2718/files/ICME11-TSG16.pdf. Diakses tanggal 1 Desember 2011.

[7] Hitt, F. (2011). Construction of mathematical knowledge using graphic calculators (CAS) in the mathematics classroom. *International Journal of Mathematical Education in Science and Technology*, 42(6), 723-735.

[8] Budhiawan, Ignatius Candra. (2012). Upaya Mengatasi Kesulitan Belajar Siswa Kelas VII SMP Kanisius Pakem Yogyakarta Pada Pokok Bahasan Segitiga Dengan Memanfaatkan Program Geogebra Dalam Proses Pembelajaran Remedial. Yogyakarta: Universitas Sanata Dharma Yogyakarta (diakses dari www.library.usd.ac.id/ pada tanggal 28 Januari 2013).

[9] Djamarah, Zain. (2006). Strategi Belajar Mengajar. Jakarta: Rineka Cipta