ENHANCING STUDENTS' MATHEMATICAL LOGICAL THINKING ABILITY AND SELF-REGULATED LEARNING THROUGH PROBLEM-BASED LEARNING

Euis E. Rohaeti
E-mail: e2rht@yahoo.com
STKIP Siliwangi, Bandung

Budiyanto, A.M
E-mail: bybudiam@gmail.com
SMAN Tegalsari Karawang,

Utari Sumarmo
E-mail:utari.sumarmo@yahoo.co.id
STKIP Siliwangi, Bandung

Abstract

This study was intented to investigate the development of students' mathematical logical thinking ability and self-regulated learningthroughProblem-based Learning (PBL). This study was a part of a master thesis and a sub-studyof a Postgraduate Research Grant from DGHE in 2013. This study was a pre-testpost-testquasi-experimental control group design involving 93 eleventh-gradestudents of a senior high school in Karawang which were chosen puposively.The instrumentsof this study were an essay test on mathematicallogical thinking, a self-regulated learning scale, and a scale measuring students' perception on PBL. The study revealed that students getting treatment on PBL attained better grades on mathematical logical thinking ability than students taught by conventional teaching, though the grades were at low level. However, there was no difference in gradesof self-regulated learning between students in the two groups though thegrades were fairly good. Also, there was no correlation between mathematical logical thinking ability and self-regulated learning with students' positive opinions toward PBL.

Keyword: mathematical logical thinking, self-regulated learning, Problem-Based Learning, perception toward PBL.

Introduction

Basically, mathematical logical thinking ability as acomponent of mathematics learning outcomes should be developed by high school students. The reason is that mathematical logical thinking ability is included in the vision and the goals of mathematics teaching (BNSP, 2006, NCTM, 2000). As for the vision of mathematics,it includes develop mathematical thinking abilities which are logical, systematic, critical, accurate, and creative.In addition, othergoals of mathematics teaching areto generate a reasonbased on mathematical patterns andfeatures, to draw generalization, as well as to proveand to clarify mathematical statements which illustrate the essence of logical thinking in teaching mathematics.

Some experts defined the term oflogical thinking differently. Capie and Tobin (as cited in Sumarmo, 1987) assessed logical thinking ability thorugh the Test of Logical Thinking (TOLT) whichcovered five components, namely controlling variable, proportional reasoning, probabilistic reasoning, correlational reasoning, and combinatorial reasoning. Other researchers definelogical thinking as to conclude using reasoning consistently (Albrecht, as cited in Aminah, 2011); to think causally (Strydom, as cited in Aminah, 2011); to think based on certain pattern or rules of inference (Minderovic, Suryasumantri, Sponias, as cited in Aminah, 2011); and to thinkinvolving induction, deduction, analysis, and synthesisactivities (Iove your eyes, as cited in Aminah, 2011). From these definitions, Sumarmo, Hidayat, Zulkarnaen, Hamidah, & Sariningsih, (2012) summarized a ctivities related to logical thinking ability, such as conclud or estimate relevant proportionon probability, correlation, combinatorial computation, and on similarity or analogy; and to generalize, prove, analyze, and synthesis some cases.

Glasersfeld (as cited in Suparno, 1997), Nickson (as cited in Hudojo, 2002), and Polya (1973) state teacher's role plays an important role in improving students' thinking abilty; teacher not only delivers information but also acts as a student, understands their way of thinking,assists them to build their knowledge,and improves their thinking ability.Essentially, these roles are in line with contructivism philosophy in which the learning process involves students' active learning,connecting information to the prior knowledge for building a more complex and meaningful schemata, and emphasis on investigating and inventing. One of teaching learning models on the basis of constructivism philosophy is problem-based learningor PBL (Barrows &Kelson; Ibrahim &Nur; Stephen and Gallagher as cited in Ratnaningsih, 2004). Problem-based learning (PBL) starts the learning activities by presenting a contextual problem relevant to the learned material. Furthermore, Ibrahim and Nur (as cited in Ratnaningsih, 2004) listed five stepsin conducting PBL; they are engaging students to the problem, managing them to learn, guiding them to explore it individually or in groups, helpingthem improve and present their work, and helping them analyze and assess theprocess of problem solving.

In approachs to teaching and learning, there are some variables that may affect students' mathematics achievement, particularly on attaining good grades; one of the variables is self-regulated learning (SRL).Several researchers (Butler, 2002; Corno & Randi, 1999; Hargis, Paris & Winograd, 1998; Schunk &Zimmerman, 1998; Wongsri, Cantwell, & Archer, 2002, as cited in Sumarmo, 2006) defined SRL in different ways but principally they proposed three similar characteristics of SRL, namelyplanning a goal, selectinga strategy, and monitoring cognitive and affective processes while answering an academic task.

Some studies reported that PBLis better on developing various mathematical abilitiesofsenior and junior high school studentsthan conventional teaching, such as Juandi (2008), Herman (2006), Permana (2004), and Ratnaningsih (2004). Those studies reported that students obtained fairly good grades on various mathematical abilities. Nevertheles, some of other studies employing various teaching approaches reported that senior high school students obtained low to average grades on mathematical logical thinking ability (Maya, 2005; Setiawati, 2014; Sumarmo, 1987; Sumarmo, Hidayat, Zulkarnaen, Hamidah, & Sariningsih, 2012). These studies found out that mathematical logical thinking problems were relatively difficult tasks for most of students. Furthermore, Qohar (2010) reported that implementing reciprocal teaching made students obtained good grades on self-regulated learning.

Based on the a forementioned background, the research questions of this study are as following:

1. Are students' grades of mathematical logical thinking ability and their N-Gaintaught by PBL higher than the grades of those who are taught by conventional teaching method?
2. Are students'gradeson self-regulated learningtaught by PBL higher than the grades of students who are taught by conventional teaching method?
3. Is there any correlation between mathematical logical thinking ability and self-regulated learning?
4. What are students' perceptions toward PBL?

Theoritical Review

Mathematical Logical Thinking and Self-regulated Learning

Capie and Tobin (Sumarmo, 1987) measure dstudents' mathematical logical thinkingability through the Test of Logical Thinking (TOLT) that consists ofcontroling variable, proportional reasoning, probabilistic reasoning, correlational reasoning, andcombinatorial thinking. Other researcher proposed the definition of logical thinking as well (Albrecht, Minderovic, Ioveureyes, Sonias, Strydom, Suryasumantri, as cited in Aminah, 2011). Logical thinking or thinking sequentially is defined as concluding through reasoning consistently (Albrecht, in Aminah, 2011), thinking causally (Strydom, in Aminah, 2011), thinking by following rules of logical inference to draw conclusion (Suryasumantri, Minderovic, Sponias, as cited in Aminah, 2011), and thinking involvingactivities on induction, deduction, analysis, and synthesis (Ioveureyes, cited in Aminah, 2011). Having analyzedideas of several writers, Sumarmo et all (2012)listedthe indicators ofmathematical reasoning as follow: a) to draw analogyand generalizationas well asto generate conjectures; b) to draw conclusion logically through the rules of inference, to compose a valid argument, and to examine the validity of an argument;and c) to prove the argument directly and indirectly using mathematical induction. Moreover, Sumarmo (*ibid*) summarizesix components of logical thinking, namely logical reasoning, controlling variable, proportional reasoning, probabilistic reasoning, propositional reasoning, combinatorial reasoning, and corelational reasoning.

There are some variables in teaching and learning process that might affectstudents' mathematical ability; one of them is self-regulated learning (SRL).Bandura (as cited in Sumarmo, 2006) defines the term SRL as an ability to observe someone's behavior. Furthermore, he suggests three phases in conducting SRL: observing and monitoring him self or herself, comparing his or her position with a particular standard, and giving either positive or negativeself-response.There are several activities related to SRL,includingself-evaluation, managing and transforming, determining goals and planning, collecting information, noting and monitoring, drawing a consquence, thinking of and repeating, seeking social assisstance, and reviewing some notes. Hargis (cited in Sumarmo, 2006) defines SRL as an attempt to deepen and manipulate associative network in a certain field, and to monitorthe process.The SRL itself was neither a mental ability nor an academic skill, such as reading ability, but it is a self-directive process that is transformed into a particular mental abilty. Yang (as cited in Sumarmo, 2006) found out that students with high SRL tended to learn better in their own control, to have ablility to control, evaluate, and manage their learning effectively, to save their time while working on their tasks, and to manage their time efficiently. Zimmerman (as cited in Zimmerman & Schunk (Eds). 2001) define SRL as a learning process affected by someone's thinking, feeling, strategy, and behavior which are orientedto achieve his or her own goals. Moreover,they (as cited in Sumarmo, 2006) state three main phases in thecycle of SRL,namely planningfor learning activity, monitoring learning progress, and evaluating learning outcome thoroughly. On the other hand, Woolfolk (as cited in Sumarmo, 2006) identifies some factors affecting SRL:knowledge, motivation, and self-discipline. In order to possess high SRL, students should be aware of their selves, the learned subject, tasks, and learning strategies, as well as application of the subject.Students with high SRL show high learning motivation and interest on completing their tasks, high self-discipline and awarenessof the reason why they should learn, andshow capability on selecting and solving their tasks on their own control, not on their external control.

Pintrich (as cited in Sumarmo, 2006) proposesfour kinds of strategiesfor improving

SRL: self-regulated thinking strategy, self-regulated motivation and feeling, self-regulated behavior strategy, andself-regulated contextual strategy. However, self-regulated learning cannot be taught but it should bedevelopedactively and continuously (Ghozi, 2010). Aswandi (2010) and Sauri (2010)propose four steps for improving self-regulated learning in mathematics teaching and learning, those aregiving the meaning of self-regulated learning, adjusting activities that portray the indicators of self-regulated learning, performing the model of self-regulated learning, and conducting integrated mathematics teaching and learning continuosly.

Problem-based Learning

Some experts have conducted in-depth analysis on problem-based learning (Barrows &Kelson; Ibrahim &Nur; Stephen & Gallagher; as cited in Ratnaningsih, 2004). The researchers suggest that problem-based learning is a teaching learning approach which begins the classroom activities by presentinga contextual problem relevant to the learned content. The problem should have some characteristics, such as it should be connected to curriculum, structured or unstrctured, open-ended;the process is carried out in stages; students actively solve the problem and teacher acts as a facilitator; students only receive guidance and not formulas or procedures for solving the problem; and teacher carries out authentic assessment.

The main differences between problem-based learning and conventional teaching approach are the phase and the role of the problem. In conventional teaching, a problem is presented at the end of an explanation and as an assignment or application of a particular concept. Whereas in problem-based learning, the problem is presented in the begining of a learning activity for motivating students to acquire the concept through investigation, invention, problem solving,as well as for encouraging students' self-directed learning. Here, the role ofteacher as a facilitator are posing relevant questions, monitoring the lesson, assessing students' thinking ability, motivating them to actively participate in learning activities, compiling relevant tasks, and managing the students to work in group enthusiastically. The role of students as an active problem solver are actively participating in learning process, communicating with other students, and constructing understanding toward the presented problem. There fore, theproblem should be challenging, unstructured, and motivating students to solve and create relevant context to the learning objectives.

IbrahimandNur(ascitedinRatnaningsih, 2004) listed five steps inproblem-based learning: a) orientation students toward the problem, b) managing them to understand it; c) guiding them to work individually or in a group, d) motivate them to improve and present their work, e) analyzing and assessing the process of problem solving. Looking at the steps, problem-based learning follows the constructivism philosophy in which students learn actively through assimilation and accomodation processes. When discussion is not satisfactory enough, it is teacher's role to carry out scaffolding activitessuch as proposing question for helping or directing studentsfind the solution.

NCTM (1993) propose several important things that should be considered in mathematics teaching and learning: a) selecting the correct mathematics tasks which are relevant to the mathematics content, understanding, interestand prior knowlegde ofthe students in order to stimulate the development of students' mathematical ability, b) motivating students to obtain a meaningful learning and to develop their mathematical disposition, c) administering a discussion for reinventing and developing students' mathematical ideas, d) participating in learning situation to motivate students for the escalation of mathematical power, e) analyzing students' learning participation.

Related Studies

Several studiesconducted to high school students reported the benefits of PBLin improving various mathematical abilities and dispositionbetter than conventional teaching (Herman, 2006; Nur, 2010; Permana, 2010; Ratnaningsih, 2004).These studies reported that the students taught by PBL obtained fairly good grades on various mathematical abilities in which the grades were better than the students' grades in the conventional teaching group. However, on mathematical logical thinking ability (MLTA) employing PBL, Setiawati (2014) and Sumarmo (1987) found out that students' grades were considered very low (40% -45% out of ideal score).Moreover, Maya (2005) and Sumarmo et al. (2012) discovered that students of senior high school achieve average grades (60% out of ideal score) on MLTA.These findings demonstrated that problems of mathematical logicalthinking wererelativelydifficult for most of senior high students.Different finding was reported in Qohar (2010) that reciprocal teaching made sudents obtaina high grade on SRL.

Regarding correlationbetween mathematical abilities and affective learning outcomes, many studies reported inconsistent findings. For example, several studies (Ratnaningsih, 2007; Sugandi, 2010; Wardani, 2010, Qohar, 2010;Yonandi 2010) reported there was a correlationbetweencognitive and affective components of mathematical learning outcomes.However, other studies (Permana, 2010;Sumarmo, et al., 2012;Sumaryati, 2013) reported there was no correlation between mathematical abilitiesanddisposition.

Method

This study was intended to analyze sudents' achievement on mathematical logical thinking ability and self-regulated learningthrough problem-based learning (PBL). This study is a part of master thesis (Budiyanto, 2014) and a sub-study of a Postgraduate Research Grant from Directorate General of Higher Education (DGHE) (Hendriana, Rohaeti, & Sumarmo, 2013). This study was a pre-test post-testquasi-experimentalcontrol group design involving 93 eleventh-grade students of a state senior high school in Karawang which were chosen purposively. The instruments of this study were an essaytest on mathematical logical thinking, a self-regulated learning scale, and a questionnaire measuring students' perception on PBL.The sample of mathematical logical thinking test, mathematical disposition scale, and students' perception on PBL are as follow:

1. Sample of mathematical logical thinking test

   Observe these cases carefully, and then answer the question: Which one of the four cases below is similar to the number of ways to combine these five digits 1, 2, 3, 4, and 5 into three different permutation of numbers.Write mathematical concept in each case andexplain your answer!

   a) To arrange male double from five male players of badminton.
   b) To selectthree people from fivecandidates foroccupying a leader, a secretary, and finance personnel.
   c) To arrange a teamof mathematics contest composed of three out of five students.
   d) To select the first, thesecond, and the third champion from five finalistsin a beauty pageant.

2. Sample item of mathematical logical thinking test

   A small restaurant prepares 7 food packets A and 6 food packets B. A family consists of a grandfather, a father, a mother, and three kids visit the restaurant for taking lunch.Each personis allowed to selectone packet only.

   a) Which packetbetweenA and B hasa greater chance to be picked by grandfather? Write the formula to answer the question!
   b) Suppose grandfather, father, and mother have chosen their food. Now the three kids willchoose the food

together. Howmany permutations can be selected by the kids? Write the formula to answer the question!

Result and Discussion

Mathematical Logical Thinking Ability, Self-regulated Learning, and Students' Perception on Problem-based Learning

Students' grades on mathematical logical thinking ability (MLTA), their N-Gain of MLTA, self-regulated learning (SRL), and their perception on problem-based learning(P-PBL) were presented in Table 1.

Table 1 shows that there was no difference in students' grades ofMLTA for both groups in the pre-test since the grades for both groups were considered low (about 25% out of ideal score). In the post-test, students'grades of the group taught by PBL were better on MLTA(54.70%out of ideal score) than students' grades of another group (48.70% out of ideal score), and both of grades were still considered low. Analysis of the mean differences of students'grades on MLTAin both teaching approaches were presented in Table 2.

These findings were similar to the findings of Setiawati (2014), Sumarmo (1987), and Sumarmo et al. (2012). Also, the study revealed that some of the difficulties students faced during solving MLTA tasks were drawing an analogy of a case on permutation and commbination, synthesizing information in a case of combination, and reasoning proportionally.

Table 1.
Mathematical Logical Thinking Ability, Self-regulated Learning, and Students Perception on Problem-based Learning

Variable	Statist.	PBL			Conventional		
		Pre Test	Pos test	N-Gain	Pre Test	Pos tes	N-Gain
MLTA	Mean	5.06	10.93	0.41	5.02	9.72	0, 32
	%	20.24	43.72		20.08	38.88	
	SD	2.15	3.85	0, 14	1.98	2.59	0, 16
SRL	Mean		100.41			98, 49	
	%		66.94			65.66	
	SD		11.03			7.99	

Note : MLTA was mathematical logical thinking ability;Ideal score of MLTA was 25
SRL was self-regulated learning;Ideal sore of SRL was150

Table 2.
Testing of Hypothesis of Mean Difference of MLTA , N-Gain of MLTA, and SRL in PBLand in Conventional Teaching

Variables	Teaching Approach	Mean	SD	N	Sig.	Interpretation
MLTA	PBL	10.93	3.85	46	0.002	MLTA $_{PBL}$> MLTA $_{Conv}$
	Conventional	9.72	2.59	47		
N-Gain MLTA	PBL	0.41	0.14	46	0.000	N-Gain MLTA $_{PBL}$> N-Gain MLTA $_{Conv}$
	Conventional	0.32	0.16	47		
SRL	PBL	100.41	11.03	46	0.148	There was no different SRL$_{PBL}$ and SRL $_{Conv}$
	Conventional	98.49	8	47		

Note: MLTA was Mathematical Logical Thinking Ability;Ideal score of MLTA was 25
N-Gain was normalizedgain
SCwasSelf-confident;Ideal score of SRL was 150
PBLwas Problem-based Learning

On normalized gain (N-Gain) ofMLTA, the result showed thatstudents taught by PBL obtained better grades(N-Gain)of MLTA(0.41) than those who were taught by conventional teaching(0.32), and their grades in N-Gainof MLTA were classified as medium. Analysis of mean difference of N-Gain on MLTA was presented in Table 4.Besides, Table 3 showed that there were no difference in SRL grades between students of the two groups though the grades were fairly good (100.41and 98.49 out of 150). Analysis of SRL mean differences was presented in Table 4. The finding on SRL in this study was similar to the findingsof previous studies (Mulyana, 2008; Permana, 2010; Qohar, 2010; Ratnaningsih, 2007; Setiawati, 2014;Sumarmo, et al., 2012; Sumaryati, 2013).

Correlation between Mathematical Logical Thinking Abilityand Self-regulated Learning

The correlationbetween mathematical logical thinking abilityand self-regulated learningwas analyzed usingcontigency tableas presented in Table 3. The result indicated that there was high correlation between mathematical logical thinking ability and mathematical disposition (C = 0,655). Analysis of the correlationand χ^2 testing hypothesis were presented in Table 4.This finding was similar with the findings ofearlier). studies (Qohar, 2010;Sugandi, 2010;Wardani, 2010). However, other studies reported that there was no correlation between hard skills and soft skills of mathematics (Permana, 2010; Sumarmo, et al., 2012; Sumaryati, 2013; Yonandi, 2010This finding illustrated inconsistent findings with the previous studies which highlighted the existence of correlation betweenhard skills and soft skills of mathematics.

Students' Perception on Problem-based Learning

Students' perception toward PBL was fairly good(132.28 or 66.14% out of ideal score). They demonstratedpositive opinions toward PBL. Positive statements,such as*Students' worksheet comprises challenging mathematics problems* or*Students' worksheet asks me to examine the accuracy of my own work*, were responded positively (strongly agree or agree). Moreover, negative statements, such as *Teaching and learning mathematics restrictme to choose excercises myself* or *The situation during teaching and learning mathematics is boring*were responded contradictory (disagree or strongly disagree).

Table 3.
Number of Students based on Level of MLTA and Level of SRLin PBL Class

MLTA	Self-regulated Learning: Low	Medium	High	Total
Low	3	16	0	19
Medium	0	16	0	16
High	0	3	8	11
Total	3	35	8	46

Table 4.
Pearson-Chi Square Test and Contigensi Coeffisien Between MLTA and SRL

Pearson-Chi Square (χ^2)	Dk	Contigency Cofficient (C)	Sig.
34.530	4	0.655	0.000

Conclusion

Students' grades in the group taught by PBL on mathematical logical thinking abilityand their N-Gainwere better than the grades of students of the group taught by conventional teaching. However, students' grades of mathematical logical thinking ability were at a lowlevel though their N-Gains werefairly good. Furthermore, there was no difference in grades onself-regulated learning between both groups though students' grades werecategorized as medium. Some difficulties students faced during solving the tasks onmathematical logical thinking were drawing an analogy in cases related to permutation and combination, synthesizing information in a case of combination, and reasoning proportionally. However, there was highcorrelation between mathematical logical thinkingability and self-regulatedlearning with students' positive perception toward PBL.

Problem-based learningis accounted successful in fostering students' mathematical logical thinking ability. However, teaching and learning activity were not sufficient enough for obtaininga high grade on self-regulated learning, since acquiringself-regulated learning required a continuous process. Although mathematical logical thinking ability was a difficult task for most of the students, this ability should be improved. Due to the limited time in conducting this study, itis recomended for further study thatteaching and learning process for the improvement of mathematical logical thinking and other high-level mathematical thinking abilities should be arranged for acquiring essential mathematics substances, such as by providing the appropriate learning materials to fit with students' need. Improvement in mathematic hard skills and soft skills should be conducted appropriately through accustoming students to materials and teacher's modelling.

References

Aminah, M. (2011). *Mengembangkan kemampuan berpikir logis matematis melalui pembelajaran metakognitif*. (Unpublished paper). Presented in a dicussion at School of Postgraduate Studies, Indonesia University of Education. Unpublished

Aswandi. (2010). "Membangun Bangsa melalui Pendidikan Berbasis Karakter". *Pendidikan Karakter*. *Jurnal Publikasi Ilmiah Pendidikan Umum dan Nilai*. Vol. 2. No.2. Juli 2010.

BNSP [Badan Nasional Standar Pendidikan). (2006). *Panduan Kurikulum Tingkat Satuan Pendidikan (KTSP,* 2006*)*. Jakarta.

Budiyanto, A.M. (2014). *Meningkatkan kemampuan berpikir logis dan kreatif matematik serta kemadirian belajar siswa SMA melalui Pembelajaran Berbasis Masalah.*(Unpublished thesis). Postgraduate Study, Siliwangi School of Teacher Training and Education, Bandung.

Ghozi. (2010). *Pendidikan Karakter dan Budaya Bangsa dan Implementasinya dalam Pembelajaran.* Paper presented at Pendidikan dan Pelatihan Tingkat Dasar Guru Bahasa Perancis Tanggal 24 Okober s.d 6 November 2010.

Hendriana, H., Rochaeti, E.E., &Sumarmo, U.(2013). *Meningkatkan beragam* Hard Skills *dan* Soft Skills *Matematika siswa Sekolah Menengah melalui beragam pendekatan pembelajaran.* First Year of Postgraduate Research Grant of Directorate of General Higher Education of Indonesia.

Herman, T. (2006) . *Pengembangan kemampuan pemecahan masalah, penalaran, dan komunikasi matematik siswa SLTP melalui Pembelajaran Berbasis Masalah.* (Unpublished disertation).School of Postgraduate Studies, Indonesia University of Education, Bandung.

Hudojo, H. (2002). *Representasi Belajar Berbasis Masalah.* Prosiding Konferensi Nasional Matematika XI, Edisi Khusus.

Juandi D. (2008). *Meningkatkan Daya Matematik pada Mahasiswa Calon Guru Matematika melalui Pembelajaran Berbasis Masalah.* (Unpublished disertation).School of Postgraduate Studies, Indonesia University of Education, Bandung.

Maya,R.(2005).*MengembangkanKemampuan Matematik Tingkat Tinggi Siswa SMA melalui Pembelajaran Langsung dan Tak Langsung.* (Unpublished thesis). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Mulyana, T. (2008). *Pembelajaran Analitik Sintetik untuk Meningkatkan Kemampuan Berpikir Kritis dan Kreatif*

Matematik Siswa Sekolah Menengah Atas. (Unpublished disertation). School of Postgraduate Studies, Indonesia University of Education, Bandung.

NCTM. [National Council of Teachers of Mathematics].(1993). *Curriculum and evaluation standards for school mathematics*. Virginia: NCTM, Inc.

NCTM. [National Council of Teachers of Mathematics]. (2000). *Principles and standards for school mathematics*. Reston, Virginia: NCTM

Noer, S.H. (2010). *Peningkatan kemampuan berpikir Kritis, Kreatif, dan Reflektif (K2R) matematis Siswa SMP melalui Pembelajaran Berbasis Masalah*. (Unpublished disertation).School of Postgraduate Studies, Indonesia University of Education, Bandung.

Polya, G. (1973). *How to solve it: A new aspect of mathematical method*. New Jersey: Princenton University Press.

Permana, Y. (2004). *Pengembangan kemampuan penalaran dan koneksi matematissiswa SMA melalui Pembelajaran Berbasis Masalah*. (Unpublished thesis). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Permana, Y. (2010). *Kemampuan Pemahaman dan Komunikasi serta Disposisi Matematik: Eksperimen terhadap Siswa SMA melalui Model – Eliciting Activities*. Unpublished disertation). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Qohar, A. (2010). *Mengembangkan kemampuan komunikasi matematis dan kemandirian belajar siswa SMP melalui* Reciprocal Teaching. (Unpublished disertation). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Ratnaningsih, N. (2004). *Pengembangan kemampuan berpikir matematik tingkat tinggi siswa SMU melalui Pembelajaran Berbasis Masalah.* (Unpublished thesis). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Ratnaningsih, N. (2007). *Pengaruh Pembelajaran Kontekstual terhadap Kemampuan Berpikir Kritis dan Kreatif Matematik Siswa Sekolah Menengah Atas. (*Unpublished disertation). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Sauri, S. (2010). "Membangun karakter bangsa melalui pembinaan profesionalisme guru berbasis pendidikan nilai". *Jurnal Pendidikan Karakter* 2(2).

Setiawati, E. (2014). *Mengembangkan kemampuan berpikir logis, kreatif, dan* habit of mind *matematis, melalui Pembelajaran Berbasis Masalah*. (Unpublished disertation). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Sumarmo, U. (1987). *Kemampuan pemahaman dan penalaran Matematika siswa SMA dikaitkan dengan kemampuan penalaran logik siswa dan komponen proses belajar mengajar.* (Unpublished disertation). School of Postgraduate Studies, Indonesia University of Education, Bandung.

Sumarmo, U. (2006). *Kemandirian belajar: Apa, mengapa dan bagaimana dikembangkan pada peserta didik.* Paper presented at Seminar of Mathematics Education in Department of Mathematics,Faculty of Mathematics and Science, StateUniversity of Yogyakarta.

Sumarmo, U., Hidayat, W., Zulkarnaen, R., Hamidah, & Sariningsih, R. (2012). Kemampuan dan disposisi berpikir logis, kritis, dan kreatif matematis:Eksperimen terhadap Siswa SMA menggunakan Pembelajaran Berbasis Masalah dan strategi *Think-Talk-Write. Jurnal Pengajaran MIPA, 17*(1)*,* 17-33.

Sumaryati, E. (2013) *Pendekatan Induktif-Deduktif disertai Strategi Think-Pair-Square-Share untuk Meningkatkan Kemampuan Pemahaman dan Berpikir Kritis Matematis Siswa SMA*. Unpublished disertasi).School of Postgraduate Studies, Indonesia University of Education, Bandung.

Suparno, P(1997).*Filsafat konstruktivisme dalam pendidikan.*Yogyakarta: Kanisius.

Wardani, S. (2010). *Meningkatkan kemampuan berfikir kreatif dan disposisi matematik siswa SMA melalui pembelajaran dengan pendekatan model Sylver*. Unpublished disertasi).School of Postgraduate Studies, Indonesia University of Education, Bandung.

Zimmerman B.J. (2001) Theories of self-regulated learning and academic achievement: An overview and analysis. In Zimmerman B.J. &Schunk D.H.(Eds). *Self-regulated learning and academic achievement: Theoretical perspectives(2nd edition)*. Mahwah, NJ:Lawrence Erlbaum Associates Inc.

Yonandi (2010). *Meningkatkan Kemampuan Komunikasi dan Pemecahan Masalah Matematik melalui Pembelajaran Kontekstual Berbantuan Komputer pada Siswa Sekolah Menengah Atas*. Unpublished disertasi).School of Postgraduate Studies, Indonesia University of Education, Bandung.