Implementation of STAD cooperative learning model to improve self esteem, metacognitive skill, and concept mastery in Mathematics learning

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ABSTRACT

Instructional models receive less attention from teachers in implementing the learning process. Students Team Achievement Division (STAD) cooperative learning model was chosen to improve the existing processes for these models excel in helping students understand difficult concepts. The purpose of this study was to determine whether there is an increase in self-esteem, metacognitive skill, and mastery of the concept of the students through the implementation of STAD cooperative learning in mathematics learning. One Group Pre-test - Post-test weak experiment design was used in this study. The research subjects were students of grade 7 SMPK Penabur Kelapa Gading. Three instruments were used in this study, namely, self esteem assessment questionnaire, metacognitive skill assessment questionnaire and concept mastery essay test. Wilcoxon Signed Ranks Test was used to test whether there is a difference in the value of the pre-test and post-test on the assessment of self-esteem, metacognitive skills, and mastery of concepts. The test results shows a significant difference in the value of self-esteem, metacognitive skill, and mastery of concepts between the pre-test and post-test.

***Keywords**: Mathematics, Learning, Metacognitive, STAD, Self Esteem, Indonesia*

INTRODUCTION

Mathematics helps children to build a strong foundation for success in school and understand the things that happen in the real world. Mathematics, in everyday life, can be used as tools for understanding human's social, economic, and natural environment. Based on the interviews, it was shown that students feel sure about it, but most of them feel that they do not have adequate ability in mathematics. There are three things that are of concern. The first thing is that the need for students self-esteem have not been met so that they can not actualize themselves. Students were reluctant to express their opinions because they feel that they do not have the ability to explain. They miss the opportunity to develop a sense of belonging. When the students seem to feel that they have nothing to offer to the group, they withdraw from other class activities. The second thing is that the learning process in school has not given attention to the development of students' metacognitive skills. Students find it difficult to combine the information they need to solve problems. Students are not accustomed to evaluate the work and it leads to the recurring mistakes. The third thing is the average score obtained is only slightly above the passing standard. Although additional and remedial classes have already been conducted, but the results are not optimal. The learning process that took place today is still a teacher-centered where students tend to just listen to the explanations of the teacher. Therefore, to increase students self-esteem, metacognitive skills, and concepts mastery, the learning process needs to be repaired. STAD cooperative learning has been chosen to be the instructional model. According to some experts, this model excels in helping students understand difficult concepts. STAD cooperative learning has been applied to the study of mathematics for students in grade 7 SMPK Penabur Kelapa Gading with the topic "Statistical Data Handling". The aims of this study is to determine the increase in students self-esteem, metacognitive skills, and concepts mastery through the implementation of STAD cooperative learning of mathematics.

Stein (2007: 285) argues that mathematics focuses on the idea of mathematics teaching methods that encourage students to engage in discussions to make assumptions, questions, and agreement on an issue with the aim to discover important concepts in mathematics. This opinion is also supported by Truxaw and DeFranco (2007: 269), who argues that the involvement in the discussion of mathematics is an important first step in understanding mathematics. National Council of Teachers of Mathematics (NCTM) establishes five components that must be present in mathematics learning: (1) solving problems, (2) thinking and evidence, (3) communication, (4) linkages, (5) the representation (NCTM Executive Summary, 2000). Mathematics learning in the classroom should involve the students actively in order to optimize the use of their ability in solving mathematical problems.

Lerner and Spanier (1980) defined self-esteem as the degree of positive or negative assessment associated with the concept of a person. John Santrock (1998) argued that self-esteem is a holistic self-assessment. Coopersmith (Thomas Crowl et al, 2001) argued that the development of self-esteem depends on a person's sense of worth, competence, and ability to control community. Jones and Jones (in Thomas K Crowl, 2001: 340) said that students with high self-esteem will tend to show good academic achievement. Self esteem also affects the relationship and interaction of students with his friends. Santrock (1998) says that low self-esteem in teens can lead to uncomfortable feeling, and if prolonged can lead to depression, anorexia nervosa, violations, suicide and other negative things. John Santrock (1998) developed ten indicators of positive self-esteem which consists of: (1) provide guidance or direction to another person, (2) use the sound quality according to the situation, (3) provide an opinion, (4) sits with others during social activities, (5) work together in groups, (6) pay attention to the speaker, (7) maintain eye contact during conversation, (8) initiate communication with others, (9) maintain a comfortable distance between himself and others, (10) speaks eloquently and showed only little hesitation.

The term metacognition was introduced by John Flavell in the late 1970s, which means the cognition of the phenomenon of cognitive or thinking about thinking (1979). Ormrod (2006) defined metacognition as the ability to understand the things that we know, how to learn these things, manage, organize, and adjust our cognitive processes to maximize learning and memory. North Cetral Regional Educational Laboratory (NCREL, 1995) brought up three basic elements of metacognition, which are: (1) before or while developing a plan of action, (2) during or while regulating and monitoring plans and (3) after or while evaluating plan. Schoenfeld (1987) suggested a more specific three-dimension to describe metacognition in mathematics, namely: (1) belief and intuition, (2) knowledge, and (3) control and self-awareness. Beliefs and intuitions concern on the mathematical ideas of what it is prepared to solve mathematical problems and how these ideas form a way to solve mathematical problems. Knowledge of thinking process concerns on how accurate a person in describing his own thinking process. While self-awareness or self-regulation concerns on how well a person in maintaining and organizing things to do when solving problems and how well a person uses input from observations for directing the activities of problem solving .

Peter Airasian et al (2010) defined the conceptual knowledge as the relationships between elements in a large structure which allows the elements to function together. Bloom (Schunk, 2012) argued that concept mastery is more focused on school variables that can be changed (alterable variables), the behaviors of early cognitive (eg skills students), characteristics of affective (eg interest and motivation), and specific factors that affect the quality of learning. Bloom (Peter Airasian et al, 2010) specifically divided the levels of thinking or cognitive processes into six categories of hierarchical dimension. The first three categories, including remember (C1), understanding (C2), and applying (C3) included in the low level thinking category, while the other three categories including analyzing (C4), evaluating (C5), and creating (C6) included in the high-level thinking category.

Van Wyk (2010) argues that the cooperative learning model is a learning strategy that offers a learning experience that is more active, equal learning opportunities, and social environment of mutual support.

According to Slavin (2010a), STAD is most appropriate for teaching well-defined objectives with single right answers, such as mathematical computations and applications, language usage and

mechanics, geography and map skills, and science facts and concepts. Slavin (in The Benefits of Using STAD in a Middle School Mathematics Classroom, Shininger, 2006) suggested five major components in the implementation of cooperative learning model STAD, including a class presentation, team, quiz, scores and individual progress, and recognition of the team. Slavin (2010b) provides specific instructions regarding the system of grouping students. Each group consists of four or five members with different academic values, ethnicity, and gender. The main function of this group is to prepare its members to prepare for the quiz that will be given after the explanation of the subtopics. Scores groups play an important role in the STAD cooperative learning model.

METHODOLOGY

This research used pretest-posttest experimental research designs (Fraenkel and Wallen, 2009). The population of this study were the 114 students studying in grade 7 SMPK Penabur Kelapa Gading that were distributed into six classes. Cluster random sampling was done using a lottery to determine the experimental class. Experiment phase consisted of the provision of pre-test, the application of learning models, and post-test.

There were three kinds of pre-test and post-test in this study, (1) self-esteem assessment questionnaire, (2) metacognitive skills assessment questionnaire, and (3) concept mastery essay test. Self-esteem questionnaire consists of self and peer assessment. Metacognitive skills evaluation questionnaire and concept mastery essay test were done individually. STAD cooperative learning model consists of (1) a class presentation, (2) the working group, (3) the quiz, (4) individual improvement score, and (5) group awarding.

RESULTS AND DISCUSSION

Self esteem

Before implementing STAD cooperative learning, students were given a pre -test for self-esteem evaluation . Students were asked to assess themselves and also three other members in the group. After the implementation they were given a post test. The summary of self-esteem assessment result can be seen in Table 1.

Table 1. Self esteem evaluation

	Self-Assessment		Peer-Assessment	
	Pre-test	Post-test	Post-test	Post-test
N	20	20	20	20
Min score	20	26	26	26
Max Score	35	37	37	37
Average Score	27,60	30,85	30,85	30,85
Std. deviation	4,74	2,85	2,85	2,85

Self esteem assessment data were statistically tested using Wilcoxon Signed Ranks Test Method, non parametric Two-Related-Samples Test. The results of the difference rank can be seen in Table 2.

Table 2. Difference rank for self-esteem self assessment

Description	Self Assessment			Peer Assessment		
	N	Mean Rank	Sum of Ranks	N	Mean Rank	Sum of Ranks
Negative Ranks	4	4,75	19,00	0	0,00	0,00
Positive Ranks	14	10,86	152,00	20	10,50	210,00
Ties	2			0		

An interesting finding here is the negative ranks of four students in the result of self assessment, while there is no negative ranks in the result of peer assessment, as seen on Table 2. The negative ranks they gave to themselves was due to their observations on the their friends in the group. Elliot et al (2010: 128) said that at school age, self-esteem associated with direct observations. If there are friends in the group who are supposed to be better, then the judgment against himself will decrease.

Table 3 shows that the value of Z obtained from self and peer assessment is less than -1.96. Under the provisions of testing when the value of $Z < -0.196$, then H_0 is rejected. It means that there are significant differences between the pre and post-test result of self and peer assessment. Significant difference in the result of pre and post-test indicates that the application of cooperative learning model can improve students' self-esteem.

Table 3 Self esteem hypothesis testing result

	Z	Asymp. Sig (2-tailed)	Result
Self Assessment	-2,912	0.004	Z < -1,96 p < 0,05
Peer Assessment	-3,930	0.000	Z < -1,96 p < 0,05

Furthermore, the N-Gain obtained from self and peer assessment were tested to determine whether both assessment give equal value of N-Gain. Table 4 shows the result of Wilcoxon Signed Ranks test for N –Gain of self esteem. From the test results the value of Z is -2.940 and the p-value 0.003. Under the provisions of testing when the Z count < -0.196 , then H_0 is rejected. This means that the N- gain derived from self and peer- assessment are different.

Table 4. N-Gain test result

	Min N-gain	Max N-gain	Mean	Z	Asymp. Sig (2-tailed)
Self Assessment	-0,22	0.68	0.1995	-2,940	0,003
Peer Assessment	0.11	1,00	0.4605		

Mean value of the N-gain that was obtained from peer assessment is higher than the result from self assessment. Cooley (in Sternberg and Williams, 2010: 119) argued that self-esteem is not only determined by self-assessment but also the judgment of others about ourselves. Peer assessment make the students feel difficult when they have to assess themselves. This was shown from the comments of some students who feel worried that the result of peer assessment about themsleves will be lower than the results of their self assessment.

Metacognitive Skills

Metacognitive skills assessment carried out using a self assessment. The summary of metacognitive assessment result can be seen in Table 5.

Table 5. Metacognitive assessment

	Pre-test	Post-test
N	20	20
Min Score	2	21
Max Score	19	31
Average Score	7,6	25,45
Std. deviation	4,18	4,09
Min N-gain	0,522	
Max N-gain	0,966	
Average N-gain	0,731	

Metacognitive skill assessment result were statistically tested using Wilcoxon method, non parametric Two-Related-Samples Test. The difference rank can be seen in Table 6, which shows that there is no negative rank.

Table 6. Difference rank of metacognitive assessment result

	N	Mean Rank	Sum of Ranks
Negative Ranks	0	0,00	0,00
Positive Ranks	20	10,50	210,00

Hypothesis testing result in Table 7 shows that the value of Z is -3.924, which is < than -1.96. Under the provisions of testing when the value of Z < -0.196 , then H_0 is rejected. It means that there are significant differences between the pre-test and post-test result. Significant difference in the result of pre-test and pot-test indicates that the application of cooperative learning model can improve their metacognitive skill. This improvement occurred because the process of learning, group work, and the group score are a basic component of cooperative learning STAD. One of the basic components in cooperative learning by Johnson et al (1999) is a learning process in the group. This learning process includes their common goals, determine strategies that can be done to achieve that goal. Students who previously did not used to do the planning, the cooperative learning required to discuss with our friends in the group to determine the strategy and steps to be taken to achieve the objectives. The same thing also delivered Mohammed Nur (2005) who said that the working group is one of the main components in cooperative learning STAD. The group division in STAD cooperative learning allows students to learn from each other, especially the learning of students in the group that received a good academic grades. In groups they are trained to understand the things they know, how to learn these things, manage, regulate and adjust the cognitive processes to achieve the goal. The process of learning and group work to train students to be able to describe the thinking process more accurately. The accuracy of a person in describing the thought process included in the dimensions of knowledge on metacognitive skills (Schoenfeld, 1987).

Table 7. Metacognitive skill hypothesis testing result

	Z	Asymp. Sig. (2-tailed)	Hasil
Metacognitive skill assessment	-3,924	0.000	Z < -1,96 p < 0,05

Concept mastery

An essay test was conducted individually to evaluate students level of concept mastery. The summary of concept mastery test result can be seen in Table 8.

Table 8. Concept mastery test result

	Pre-test	Post-test
N	20	20
Min Score	26	43
Max Score	69	95
Average Score	46	73
Std. deviation	13	13
Min N-gain	0,200	
Max N-gain	0,857	
Average N-gain	0,511	

N-Gain of each indicator should be calculated, in order to determine students achievement on each indicator of concept mastery. The summary of N-Gain for each indicator can be seen on Table 9. An interesting finding in this study is that evaluating (C5) indicator which is included in the category of high-level thinking (Bloom in Airasian Peter et al, 2010: 44-45) gained a higher increase compared to "understanding" (C2) and applying (C3) indicator which included in the category of low-level thinking. It is possible because cooperative learning is an active learning that emphasizes cooperation within the group. Learning is emphasized in the discussion in the group and each member is free to give explanations, reasons and arguments for such a thing. This learning process trains students more on evaluating than understanding and applying. This is in line with the advantages of cooperative learning STAD who pointed Slavin (2010) that interactions between students in line with the increase

in their ability to argue. The other reason is that the topics covered in this research, statistical data handling, which trains the students to read graphs for interpreting and evaluating an argument.

Table 9. Average score and N-gain of each indicator of concept mastery

	C2	C3	C4	C5	C6
pre-test average score	55	46	39	20	44
post-test average score	79	78	62	83	66
Min N-gain	0	-2	-0.3	0	-1.5
Max N-gain	1	1	1	1	1
N-gain Average	0,54	0,4	0,3	0,8	0,3

The hypothesis test must be conducted to determine whether there is a difference between the score of the concept mastery before and after treatment. To determine the method of test, it is necessary to test the prerequisite. Prerequisite test consists of normality and homogenity test. Normality test was done using Kolmogorov -Smirnov test. The significance level for pre and post test are 0.143 and 0.200 respectively. Under the provisions of the test , if the significance > 0.05 then H_0 is accepted . This means that the distribution for pre-test and post-test are normal. The second prerequisite test that must be done is homogeneity test. Homogeneity test was conducted using Levene Statistics. Levene's test for data pre-test and post-test gives a significance of 0.004 . Under the provisions of the test , if the significance value < 0.05 then H_0 is rejected. This indicates that pre-test and post-test data have different variances. Based on the result of prerequisite test, it was concluded that the data are not homogeneous .

Concept mastery data was statistically tested using Wilcoxon method, non parametric Two-Related-Samples Test. The difference rank can be seen in Table 10, which shows that there is no negative ranks.

Table 10. Difference rank of concept mastery result

	N	*Mean Rank*	*Sum of Ranks*
Negative Ranks	0	0,00	0,00
Positive Ranks	20	10,50	210,00

Hence, the result of hypothesis test can be seen on Table 11. Table 11 shows that Z <1.96 and p <0.05, which means that H_0 is rejected. The test result indicates that there is significant difference between the score of pre-test and post-test. This shows that the implementation of STAD cooperative learning can enhance students' concept mastery. The increasing value of concept mastery is driven by their scores in STAD cooperative learning groups, which led to positive interdependence. Ecah member is required to contribute equally withing the group. Each of the group members have equal responsibility in the achievement of points. This encourages each member to study hard in order to obtain good results. Members with better academic grades required to teach things that are already understood to other group member.

Table 11. Concept mastery hypothesis test result

	Z	Asymp. Sig. (2-tailed)	Result
Concept Mastery Essay Test	-3,923	0.000	Z < -1,96 *p* < 0,05

CONCLUSION AND RECOMMENDATIONS

The conclusion of this reasearch are the application of STAD cooperative learning in the learning of mathematics in grade 7 SMPK Penabur Kelapa Grading can improve their self-esteem, metacognitive skills, and also concept mastery. Based on the conclusions that have been formulated and observations during the learning, there are some suggestions related to the implementation of STAD cooperative learning model : (1) Teachers should consider the proper time to implement STAD cooperative

learning, since it takes time for the students to adapt to their group, (2) STAD cooperative learning model should be designed, so it can be easier to be implemented in schools, (3) Researchers are expected to implement STAD cooperative learning model in other materials and even in other subjects, (4) Researchers are expected to implement STAD cooperative learning model to improve other variables.

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