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The Enhancement of Mathematical Communication and Self Regulated Learning of Senior High School Students Through PQ4R Strategy Accompanied by Refutation Text Reading

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ABSTRACT

This study is experiment research with control group pretest-posttest design and aimed to examine the influence of PQ4R strategy and Refutation Text, school level, and student's mathematical early knowledge toward achievement and enhancement of student's mathematical communication ability and Self Regulated Learning. Subject of study as much as 241 students of class X from three Public Senior High School from high, medium, and low school level. Research instrument consist of one set of student's mathematical communication, and one set of student's Self Regulated Learning scale. Data analysis use Kosmogorov-Smirnov Test (Test-Z), Level Test, Test-t, one-way and two-way ANOVA, Post Hoc Test (Scheffe) and also Chi-Square Test. Study found that learning with PR4R strategy accompanied by Refutation Text Reading give consistent influence compared with conventional learning as viewed as a whole, based on school level and also mathematical early knowledge. In addition, study also found: (1) there is no interaction between learning (PQ4R) accompanied by Refutation Text reading and conventional and school level toward (a) student's mathematical communication and (b) student's Self Regulated Learning; (2) there is no significant interaction between learning and student's mathematical early knowledge toward (a) student's mathematical communication ability and (b) student's Self Regulated Learning; and (3) there is association between student's mathematical communication ability and student's Self Regulated Learning.
Keywords: *PQ4R, Refutation Text, Mathematical Communication, and Self Regulated Learning.*

I. INTRODUCTION

One of the general objectives of mathematics learning which is formulated by National Council of Teachers of Mathematics (NCTM, 2000) is learning to communication (mathematical communication). Mathematics communication need to be developed in students, Baroody (1993) stated that learning must help students in communicating mathematics idea through five communication aspects such as *representing, listening, reading, discussing, and writing.* Then, he also stated that at least there are two important reasons about why communication in mathematics learning needs to be developed in students. First, *mathematics as language*, it means mathematics not only a tool to aid thinking, tool to find pattern, solving problems or drawing conclusion, but mathematics also is "*an invaluable tool for communicating a variety of ideas clearly, precisely, and succinctly.* Second, mathematics learning as social activity: it means that as social activity in mathematics learning, also as means of

interaction among students, and also communication between teacher and students. It is also an important part in *"nurturing children's mathematical potential"*.

Then, Greenes and Schulman (1996) stated that mathematics communications are: (1) main strength for students in formulating concept and mathematics strategy; (2) key of success for students towards approach and completion in exploration and mathematics investigation; (3) means for students to communicate with their friends in obtaining information, sharing and finding ideas, brainstorming, valuing and exacerbating ideas to convince others.

According to Irianto (2003), mathematics communication has not developed firmly, especially in SMP/SMU, though as stated by *National Council of Teachers of Mathematics* (NCTM (1991), NCTM (2000), and National Standard of Basic Ability in Elementary School until High School (2000) that mathematics communication is one of basic ability that is needed to be strived for its improvement as other basic abilities, such as reasoning ability, mathematics comprehension ability, mathematics communication, and problem solving.

Besides cognitive aspect, affective aspect is also important in mathematics learning. Wardani (2004) stated that affective aspect is also taking part in students' success in learning mathematics; such affective aspect is self-regulated learning.

In 1989, NCTM (Romberg, 1994 and Wahyudin, 2008) stated the role of affective aspect and cognitive aspect in learning mathematics. Both aspects simultaneously give impact in students' learning achievement. Mathematics self-regulated learning is a very important factor in determining students' success in learning mathematics. Technology development also give impact in enriching learning sources that can be accessed, it will support their learning for students who do self-regulated learning. Students who are given with PQ4R strategy learning and *refutation text* are assumed have more self-regulated learning than students who are given with conventional learning.

Besides learning factor, there are other factors which are assumed have contribution towards mathematics communication development and also students' self-regulated learning, namely, school level learning and students' mathematics early ability. Students with higher mathematics early ability and also have higher school level are assumed have higher self-regulated learning than students with lower mathematics early ability and lower school level.

Refutation Text is text which compare true ideas and false ideas. In view of constructivism idea, refutation text is the best explanation that can be accepted by people as true. In teaching and learning activity, the best explanation is conveyed by teacher who takes a source from experts or scientists, so true ideas would be the same with scientists' conception. False ideas are different or irrelevant conception from scientists conception (Hydn & Alverman, 1985; Tangdililing, 2009, 2010).

A learning activity which is assumed can be applied to develop students' mathematics communication and students' self-regulated learning among others are P4QR strategy (*Preview, Question, Read, Reflect, Recite, Review*) (Arends, 1977; Slavin, 2000) which is accompanied with *refutation text.* Strategy PQ4R is used to help students in recalling of what has been read, and can help teaching and learning process in class which is conducted with reading mathematics book activity. Reading book activity is aimed to study thoroughly chapter by chapter of a textbook (mathematics). Therefore, first main skill which must be developed and mastered by students is read the book and other sources. With reading skill, every student will enter fascinating knowledge world, understanding wisdom, and developing other skills which would be useful in life. Skillful reading activity will open broad knowledge, gate of wisdom, and future expertise. Activity and reading skill can not be replaced with other strategies. By reading, students can communicate with each other through writing. Reading can be viewed as interactive process between language and mind. As interactive process, reading success would be influenced by knowledge factor which background and reading strategy is related with self-regulated learning (Gie, 1998).

Based on explanation of background, problem formulation in this study are as follows:

1. Does enhancement of students' mathematics communication ability (KMS) and self-regulated learning (KBS) between students who are given with PQ4R strategy and *refutation text* (SPRT) are better than students who are given with conventional learning (PKV) which is viewed from: (a) students as a whole; (b) school level (high, medium, low); and (c) mathematics early knowledge (PAM) (high, medium, or low)?
2. Is there interaction between: (a) learning and school level and (b) learning and PAM towards KMS and KBS enhancement?

3. Is there association between students' mathematics communication ability (KMS) and students' self-regulated learning (KBS) in mathematics?

I. Research Method

This study is quasi experiment research with non-equivalent control group as follows.

O X O

O O

Explanation: X = SPRT Learning

O = Pretest/posttest KMS and pretest scale/post scale KYM

Research population is high school students which come from high, medium, and low level in Pontianak. Sampling of study was conducted as follows. First, three schools was selected with one school from high level school, one school from medium level school, and one school from low level school. Second, from each school, it is selected one experiment class and one control class. Experiment class is given with PQ4R Strategy and refutation text (SPPRT) and control class is given with conventional learning (PKV).

To measure enhancement of mathematics communication ability (KMS) then two tests are used, each test to measure KMS which consist of 5 items (pretest = posttest item) and one scale test of students' self-regulated learning (KBS) around 40 items with 5 options. The eq uivalence of both tests are tested by using judgments expert. As for instrument reliability KMS, it is calculated by using *Alpha Cronbach* formula and is obtained around 0,892 (high) while KBS around 0,765 (medium).

II. STUDY RESULT

The enhancement of mathematics communication ability and self-regulated learning in this study is viewed from normalization gain (N-gain). Excellence testing of SPRT than PKV in KMS and KBS enhancement as a whole uses t-test. Before conducting t-test, univariat normality test is done in advance by using *Kolmogorov-Smirnov Z.* Normality test result is N-gain KMS and PBS between student who is given with SPRT and PKV learning, each come from population with normal distribution with Sig value in a row are 0,578 and 0,078. Then, on variant equality test with *Levene test* is obtained F = 6,345 with Sig = 0,043 for KMS and F = 8,321 with sig = 0,0341 for KBS.

Because Sig value less than 0,05, it means that N-gain variant KMS and KBS for all SPRT students are not same with N-gain KMS or KBS variance for all PKV students. For data pair which homogenous is used t-test with variance assumption is equal (*equal-variance t-test*) while for data pair which non homogenous is used unequal-variance t-test. Therefore, t-test that is used is t-test without variance equality assumption and $t_{calculation}$ = 5,688 with df = 211 and Sig (2-sides) = 0,002. Sig Value (1-side) = ½ Sig(2-sides), which means Sig(1-side) = 0,002. Then, it is obtained Sig(1-side) < 0,05 so H_0 rejected. Thus, it is found that KMS improvements of SPRT students are higher than PKV students' improvement. Implication from this finding is that SPRT learning is proper to be used in replacing conventional learning at high school in Pontianak region in order to enhance students' ability in mathematics communication and students' self-regulated learning.

This study is conducted at three school level, namely, high, medium, and low school level. In this finding, in all students who have been analyzed, SPRT excellence is found in enhancing improving KMS and KBS so it bring out subsequent question, namely "Is the enhancement of student's mathematics communication ability (KMS) and PBS of SPRT is higher than the enhancement of KMS and KBS on PKV students on each school levels?" In answering such question independence sample t-test is used. Univariat normality requirement from t-test is tested by using *Kolmogorov-Smirnov* test and its result shows that normality requirement for t-test on N-gain pairs KMS or KBS on high, medium, and low level school are fulfilled.

Then, independent sample t-test between N-gain averages is conducted which is achieved by SPRT class with N-gain average which is achieved by PKV class on each school levels. Calculation of t-test testing by using SPSS and its calculation result is presented in Table 1 and Table 2.

Table 1.

School Levels	Class	Mean	t	dk	Sig(one-way)	Conclution
High	SPRT	0,385	5,204	70	0,000	H_0 is rejected
	PKV	0,206				
Medium	SPRT	0,408	4,654	66	0,0035	H_0 is rejected
	PKV	0,295				
Low	SPRT	0,522	2,453	74	0,0325	H_0 is rejected
	PKV	0,416				

Tabel 2.

School Levels	**Strategy**	***N***	**Mean**	**Main Diffrent**	**t**	**dk**	***Sig.***	**H_0**
High	SPRT	*35*	0,46	0,24	4,562	69	*0,000*	Rejectted
	PKV	*36*	0,22					
Medium	SPRT	36	0,32	0,13	3,213	69	0,003	Rejectted
	PKV	35	0,19					
Low	SPRT	36	0,30	0,12	1,234	70	0,001	Rejectted
	PKV	36	0,18					

Table 1 and Table 2 show that probability value (sig) at the three school levels is smaller than 0,05, so H_0 is rejected. Thus, students at the three school levels who are given SPRT obtain average improvement of KMS and KBS which is higher than students who are given with PKV approach. Thus, SPRT is more appropriate to be used in enhancing student's mathematics communication (KMS) and students' *self-regulated learning (*KBS) at the three levels than with PKV approach.

To test differences based on Mathematics Early Knowledge (PAM) group, enhancement differences (N-gain) between SPRT and PKV, univariat normality requirement is tested in advance before from t-test which is tested by using *Kolmogorov-Smirnov* test and its normality requirement result to t-test towards N-Gain KMS pairs or KBS in high, medium, and low PAM are fulfilled. By SPSS calculation, probability value (sig) is found towards three students' PAM group which is smaller from 0,05 until H_0 is rejected. Thus, students at the three PAM groups who are given SPRT learning obtain average enhancement of KMS and KBS which is bigger than students who are given with PKV approach. Thus, SPRT learning is more appropriate to enhance mathematics communication (KMS) and students' self-regulated learning (KBS) at the three school level than PKV approach.

Then by using two ways ANOVA test, it is found that there is no interaction between learning and school level or interaction between learning and PAM group towards KMS and KBS enhancement. No interactions which cause main effect become meaningful. In ANOVA result, for main effect which come from learning source, it is obtained $F_{calculation}$ = 23,56 with Sig = 0,000. Because Sig value less than 0,05, it means

that there is differences of average N-gain KMS and KBS of students who get SPRT and average N-gain KMS and KBS of students who get conventional learning (PKV). Association test with Pearson-Chi Square to see whether there is association or no association between communication ability (KMS) and students' *self-regulated learning* (KBS) conclude that there is association of two abilities although the association in on medium level.

III. Discussion

1. Mathematics Communication Ability (KMS) Based On Learning, School Level, and Mathematics Early Knowledge (PAM)

Students' mathematic communication ability is students' ability in drawing, making mathematics expression, or writing their answers with their own language related with various situation or mathematics ideas which are presented in the form of picture, diagram, graphic, symbol, story item, or a mathematics model. This study result shows that enhancement of students' mathematics communication ability whether as a wholae or between school level and mathematics early knowledge who are given with SPRT learning significantly better compared with students who are given conventional learning. It is shown with average value enhancement with SPRT learning around 0,50 (medium), higher than conventional learning around 0,28 (low). The study result also give description that SPRT learning can improve students' mathematics communication ability. Although there is still no good result because students' average ability is still at the medium level. It is because through learning with SPRT students are used to solve mathematics problem, by trying to understand and solve their own problems or by discussing with their friends. Students dependence that always look at teacher example become less so when they are faced with new problem that unfamiliar for them, students is not desperate easily to try to solve the problem. This study result is in accord with Cooke and Buchholz (2005: 256) suggestion, where teacher is able to train students in making relation between mathematics and language. Through SPRT learning, teacher train students to understand relationship between mathematics and language. According to Baroody (1993: 99), one of the reasons why mathematics learning focus on communication is because mathematics is essentially a language, namely, mathematics is more than a thinking aid, tool to find pattern, solve problem, or make conclusion, mathematics also is a tool which is invaluable for communicating various ideas clearly,

accurately, and briefly. In this SPRT learning, students are trained to communicate various mathematics ideas by making picture, diagram, graphic, table, symbol or mathematics model, composing story item, or making questions or explanation in the written form with their own language related with process and result of mathematics problem solving which is obtained.

This finding is also in accord with recommendation from NTCM which suggest teacher to encourage students in applying various strategies in solving problem which is related with mathematics communication. This strategy include manipulating, trial and error, trying case per case, guessing and checking, writing all possibilities, collecting and organizing data in the table, finding a pattern from table, drawing a diagram, and working backward (NCTM, 1989: 76 and NCTM, 2000: 53). Even more explicit in NCTM (2000: 53) is stated that presenting various methods in learning is main principle in enhancing mathematics communication. It is stated further that communication is an essential part from mathematics and mathematics education. This opinion shows the important of communication in mathematics learning. Through communication, students can deliver their ideas to teacher and to other students. It means that one of the successes in teaching and learning program among other depends on communication form which is used by teacher when he/she interacts with students.

Based on statistical test which is conducted, it is concluded that learning give significant impact towards students' mathematics communication ability (KMS). As for school level give significant impact towards mathematics communication ability. This finding is supported with enhancement of students' average grade that are given with SPRT learning for all school levels are always higher than students who are given with conventional learning.

As for mathematics early knowledge give significant impact towards mathematics communication ability. The enhancement of students' average grade that have early knowledge with SPRT language are around 0.52 higher than conventional learning around 0.35. The enhancement of average grade of students' mathematics communication ability who are given with learning with SPRT learning towards students who have high knowledge are better than students who have medium or low knowledge. Students who have medium knowledge are better than students who have low knowledge. It can be understood because to solve various items in mathematics

communication, it is needed knowledge preparedness to solve such problem. Students who have high knowledge, usually have knowledge preparedness which are better than students who have medium and low knowledge.

2. Students' Self-Regulated Learning in Mathematics Based On Learning, School Level, and PAM

Self-regulated learning is active and constructive process which include: learning initiative, diagnosing learning needs, determining learning objective, arranging and controlling students' performance, arranging and controlling cognition, motivation and behavior, viewing difficulties as challenge, finding and using learning source which is relevant, selecting and applying learning strategy, evaluating process and learning output, and self-efficacy.

Data analysis result wholly, whether it is viewed from learning factor and school level and also mathematics early knowledge (PAM) shows that students' mathematics self-regulated learning who are given with SPRT are better than students who are given with conventional learning. If it is viewed from average score of students' self-regulated learning, so students who are given with learning with SPRT learning shows quality of self regulated learning which is better than students who are given with conventional learning.

Self Regulated learning has dynamic nature, it means that self-regulated learning always change. There are aspects that can survive in the long term and also there are aspects that can not change with temporary situation. It means that there is possibility in improving or correcting someone self-regulated learning. Learning with SPRT approach can give opportunity to students to find and develop knowledge for themselves, and also give possibility to students to be more active in learning, brave to express their opinion and appreciate others opinion. It is assumed that students who apply self-regulated learning who are given with SPRT approach are better than students who are given with conventional learning. But, of course, mathematics learning like this is not enough to be conducted only on several occasions.

Self-regulated learning can be enhanced through mathematics learning because mathematics have various characteristics which are relevant with ten aspects of self-regulated learning, such as, consistent, obey to the principle, universal, logic, and systematic. Mathematics learning which can realized such aspects is learning which always direct students to interact with each other through discussion strategy in group in

studying mathematics problem which is studied by using mathematics knowledge which they possess.

Result of test-t towards both average grade of students' self-regulated learning after learning shows that there is significant differences between the two grades. It shows that application of SPRT approach give bigger influence than PKV approach in enhancing students' self-regulated learning. There is motivation and observation which is conducted during learning process which is assumed to be factor which trigger the enhancement of students' self-study learning on SPRT class. Teacher role in SPRT learning as motivator, make learning focus on students so learning can run democratically through group or can work independently.

Schunk & Zimmerman (1998) describe self-regulated learning that learning is a main part comes from influence of developing their own mind, feeling, strategy and learning behavior which is oriented towards the achievement of learning objective. Motivation consistently is viewed as determinant factor of students' learning and achievement. If students do not have motivation, it will make problem for themselves, because learning is a process to achieve academic ability which is full of barriers. Such barrier can be in the form of lack of motivation to achieve high achievement. Observation of motivation to get high achievement as individual activity is started from doing initiative action, implementing and completing learning activity. This observation is conducted freely without intervention from anybody else.

IV. Conclusion and Suggestion

A. Conclusion

Based on analysis result, finding, and discussion which has been discussed from the previous chapter, it can be stated several conclusion as follows.

1. Viewed from all students, average of communication ability enhancement and self-regulated learning (KBS) of students who are given with SPRT are better than PKV. On school level (high, medium, and low), average of KMS ability enhancement of KMS and KBS who are given with SPRT is better than students who are given with PKV, although ability enhancement classified in medium category.. As for if it is viewed from PAM (high, medium, and low), KMS and KBS enhancement average is better than students who are given with PKV.
2. There is no interaction between learning (SPRT and PKV) and school level towards KMS and KBS ability enhancement. It is also found that there is no interaction

between learning (SPRT and PKV) and PAM group towards KMS and KBS enhancement.

3. There is positive association between mathematics communication ability (KMS) with students' self-regulated learning (KBS) in mathematics as a whole or based on SPRT learning.

B. Suggestion

Based on conclusion and implication from this study, the suggestions are given as follows:

1. SPRT learning is recommended to be applied in mathematics learning process in Senior High School (SMA), or at least as model alternative of mathematics learning. Although there is no approach or learning model which is appropriate to all students' condition which is heterogeneous, this study result shows that the use of SPRT learning is better compared with conventional learning.
2. Because mathematics communication ability and mathematics self-regulated learning is very important in mathematics learning, such abilities must be studied and developed from elementary school until college.
3. To implement learning with SPRT learning well, teacher must know students' early concept before learning can be used as learning basis to overcome students' misconception. Students' conception need to be revealed in *refutation text* and then is given solution to overcome it. Several predictions and anticipation which have been prepared well in learning scenario will make teacher easier to do appropriate act when students find difficulties in solving problem, so it will expedite the earning process in SPRT learning.
4. For next researcher, this study can be continued by studying the impact of learning with SPRT learning towards other mathematics abilities, such as mathematics comprehension ability, mathematics communication, and mathematics reasoning. This study also can be continued by studying each indicator from mathematics comprehension ability or mathematics communication, in order to obtain more accurate results about what indicators which can be improved through learning with SPRT learning.

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