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The Effectiveness of Self-Assessment toward Understanding the Mathematics Concept of Junior School Students

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Abstract

This study aimed to analyze the effectiveness of self-assessment toward the understanding of the mathematical concept of high school students. The objects of this study were all non-superior students of grade VIII in SMP Negeri 2 Singaraja school year of 2015/2016. This research used random sampling technique. The research design used was post-test only control group design. Data understanding of mathematical concepts of students was obtained through the test description with the reliability of 0.71. The data obtained were analyzed using the t-test. The results of the analysis showed that self-assessment effectively improved students' understanding of mathematical concepts.

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1. Introduction

One of the most serious problems in Indonesia today is the education system that is too oriented to the development of the left brain (cognitive) and less attention to the development of the right brain (affective, empathy and feel). In fact, the practice of subjects related to the education of the character also emphasizes on aspects of the left brain (memorizing). Whereas the formation of human values or character must be done in systematic and continuous involving aspects of knowledge, feeling, loving and acting (Rustaman, 2011).

It is realized or not in international relations that the reversal of a nation is determined by three main parameters which are called as Science literacy, Mathematics Literacy, and Language Literacy (Permanasari, 2014). It is further

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said that the analysis of the achievement of math literacy and Science of 2012 showed that about 50% of students could only solve simple quantity problems; about 50% of students could not solve the basic quantity problem in simple arithmetic operations though; and almost all students could not solve more complex quantity problems. This may be caused by the implementation of learning package that does not run according to content standards, and too many contents (Sudiarta, 2008, Permanasari, 2014).

To overcome this matter, there is no other way that can be taken except to improve the process of mathematics and science learning from various aspects. The orientation of education is the glory of the future, therefore the delivery of education does not sanctify a change or a refinement if the experience leads to make that change for a better future (Suparta, 2014). In this case, it can be understood how the importance of making improvements in the conduct of education in order to realize meaningful learning. One element of education in mathematics learning that aims to train thinking and reasoning, develop creative activities, develop divergent thinking, and problem-solving abilities.

Mathematics is defined as the queen and servant of science which means that mathematics is the source of another science, in other words, there are so many sciences of discovery and their developments depend on mathematics. Essentially, mathematics is a structured science, in which mathematical concepts are structured in a hierarchical, structured, logical, and systematic way. This means that in mathematics there is a prerequisite concept that serves as a basis for understanding the next concept. A concept is structured on the basis of previous concepts and becomes the basis of concepts so that misconceptions of a concept result in a misunderstanding of subsequent concepts (Suherman *et al.*, 2003). Therefore, an understanding of concepts must be possessed by students in learning mathematics. Retention of students' understanding of a concept becomes deeper and more lasting as students associate mathematical ideas, makes interrelated mathematical relationships between mathematical topics and relates mathematics to other subjects (NCTM, 2000).

The fact shows different evidence from what we expect. Math becomes one of the less favored subjects by the students, and although the test scores obtained by the students are quite high the students have difficulties when students are asked to write down the reasons for the answers given by the students. The authors assume that it is all because the form of tests usually used tend to be in the multiple choice test, which is not in accordance with the 2013 curriculum.

Sudiarta (2013) states that there are some obstacles faced by students in learning mathematics, such as the lack of students 'ability to invent and define more complex problems, choose and use strategies, appropriate algorithms to solve problems, analyze friends' answers and compare with their own answers to confirm the answer and find out the location of the error in answering, communicate the results of their work, and reflect on what they have done. Mathematics learning should be able to give students more opportunities to explore, use reasoning to construct evidence, or explain mathematical ideas and statements, integrate mathematical concepts to solve problems, communicate ideas, and correct their own work done. It all certainly has an impact on the retention of students' understanding of mathematical concepts that has lasted for a long time inside them.

Understanding the concept of mathematics must be mastered by students well because to solve the problem, the students must know the relevant rules based on the concepts (Dahar, 2011). The concepts in mathematics are organized systematically, logically, and hierarchically from the simplest to the most complex (Suherman *et al.*, 2003). Therefore, the process of learning mathematics should be interesting and meaningful so that students can master mathematical concepts well. With a good mastery of mathematical concepts, the student's learning outcomes will also be good. This can be achieved if the learning process is meaningful, and the assessment used is also in accordance with the applicable curriculum by using authentic assessment. One of the authentic assessment types is self-assessment. "Self-assessment is an assessment technique for attitudes, knowledge, and skills that are done alone by the students reflectively (Kemendikbud, 2012).

McMillan and Jessica (2008) define self-assessment as a process in which learners 1) monitor and evaluate the quality of their thinking and behavior when learning and 2) identify strategies that enhance their understanding and skills. In this case, self-assessment occurs when learners assess their own work to improve their performance to identify the difference between current performance and their desire. Meanwhile, according to Rolheiser & Ross (2005) self-assessment is a way to look at the students. Through self-assessment, learners will know the strengths and weakness, and then the weakness becomes the goal of improvement.

Reflecting is an important component of self-assessment, which occurs when learners think about how their work meets the criteria. Learners analyze the effectiveness of their efforts and plan for improvement. Black & William (1998) state that self-assessment is really important for the purposes of making decisions about their own work. Furthermore, Black & William state that this strategy does not merely involve appraisal, but more than that and it can

provide an advantage for the exploration of the assessment process in a fundamental way. Ideal self-assessment can take place every meeting in various forms, it does not necessarily require a formal session, and this assessment can be improved through the statement of the learners' thoughts and ideas.

Black & William's ideas are supported by Johnson & Johnson (2002) that the importance of involvement of learners in the assessment is based on assumptions: (a) learners tend to improve the quality of decisions. Involvement of learners in making decisions makes increased use of available resources, (b) learners are likely to increase their commitment to applying quality assessments. Direct involvement of learners in planning will result in a stronger commitment to implement assessment procedures, (c) learners tend to make changes through feedback, (d) learners are motivated to improve their performance through tasks assigned and feedback on (e) learners are more motivated to learn and improve positive attitudes toward the learning process and assessment, (f) involvement of learners tends to increase self-assessment.

This self-assessment is helpful in building students' sense of responsibility in learning, self-monitoring in learning activities, instilling awareness for self-improvement, and building logical arguments (Herman, 2008; Marhaeni & Artini, 2015). Another impact that arises is that students feel encouraged to continue learning, happy in following the lesson, and motivated to find something better.

The main goal in self-assessment is to help students acquire the skills and habits of thinking and improve their learning independence. Self-assessment supports the current view of students who are actively involved in the learning process. Students learn to monitor whether they have understood the explorative learning outcomes and metacognitive processes. Once the metacognitive skills are acquired, the students can independently adapt their learning and show self-reflection, self-monitoring, and self-adjustment. Thus, with such self-assessment students will actively engage in creating their own understanding, students must learn to be critical assessors who understand information, connect it with prior knowledge, and use it for new learning. Students have a greater chance of taking responsibility for their own learning. Assessment of students in learning mathematics allows teachers to draw conclusions about student learning needs, student progress in achieving curriculum goals, and the effectiveness of mathematics programs. In addition, with self-assessment students can know where the location of the lack of understanding of student on concepts. Black & William (1998) state that students should be trained in self-assessment so that they can understand the main purpose of learning and thus students can understand what they must do to achieve their goals. So, students will be motivated to improve themselves so that students can understand the material being studied and understand the concept of the material. The purpose of this study is to determine whether the understanding of mathematical concepts of students who received learning along with self-assessment is better than understanding the concept of mathematics for students who follow conventional learning.

2. Materials and Methods

This type of research was a quasi-experimental research (quasi-experiment). The effectiveness tested in this study was the influence of learning by doing self-assessment towards understanding the concept of mathematics of Student Grade VIII in SMP Negeri 2 Singaraja. The objects of this study were students of Grade VIII SMP Negeri 2 Singaraja school year of 2015/2016 as many as 487 students and were divided into 13 classes. The sample in this study was determined from the population by random sampling technique. Before the sampling was taken in class VIII SMP Negeri 2 Singaraja, firstly done equality test on the population with variance analysis of one lane or often called F test. Furthermore, the normality and homogeneity were done before the hypothesis test. A summary of one-way ANAVA test calculations can be seen in Table 1 below.

Table 1
A summary of one way anava test result

Variation Source	JK	***dk***	RJK	$F_{calculate}$	F_{table}
Between	2414,813	12	201,234	1.570	1.772
in	60761,959	474	128,190		
Total	63176,772	487			

Based on the equivalence test, it resulted the value of $F_{calculate}$ = 1,570 and F_{talel} = 1,772. Since $F_{calculate}<F_{table}$, so it could be concluded that the population was equivalent. Because the population used was equivalent, then the

samples could be taken randomly. With drawing system, two groups were selected to determine the control group and experimental group. From the draw, it obtained class VIII 4 as experimental group and class VIII 3 as a control group. In the experimental group, they were given learning treatment with self-assessment and control group with conventional learning. The independent variable in this study was self-assessment while the dependent variable of this research was conceptual understanding.

The data of this research was a score of understanding of students on mathematical concepts which was collected through concept comprehension test. This test was given at the end of the study in both groups. The understanding concept test was in the form of description, where the questions have been tested for the validity and reliability. Post-test results were examined using the scoring rubric of understanding on mathematical concepts. The test result data of understanding on concepts were analyzed using T-test one tile by the significant level of 5%. Relating to a used statistic in this study, then normality and homogeneity tests were also conducted. The normality test of data distribution in this study used Chi-Square test while homogeneity test variance was analyzed by using F-test.

3. Results and Discussions

The validity test on the content of the understanding of mathematical concepts was done by expert judgment, and in this case, this research used two experts. Based on the calculation result, the validity coefficient of the instrument content to measure students' mathematical concept understanding was 1.00. In conclusion, the validity level of the instrument content was very high or feasible to use. The results of empirical tests showed that from 7 items tested, they were all valid. Then, from the 7 questions, 5 questions were selected that would be used as post-test questions. The results of reliability test analysis for the questions showed that its reliability coefficient was as many as 0.71, so it was feasible to use. The data of the students' understanding of mathematical concepts obtained can be seen in Table 2.

Table 2
Data analysis summary of students' understanding of mathematics concept

	Groups	
	Experiment	Control
n	39	37
$\overline{X}$	68,667	61,865
SD	10,658	11,099

To find out whether the understanding of mathematical concepts of students who followed the learning along with self-assessment was better than who followed the conventional learning, then the test on H0 was also conducted. Before the hypothesis test was done, the prerequisite testing of the data distribution, including normality test and homogeneity test were done first. Here is the explanation of the normality and homogeneity test results.

The normality test result of data distribution related to the understanding on the mathematical concept of the students with Chi-Square test, obtained the $X^2_{calculate}$ on experiment group was 2.960 and the $X^2_{calculate}$ value on control group was 1.760. Meanwhile, the X^2_{table} on the experimental group was 11.070 and X^2_{table} on control group was 12.592. From the calculation above, it showed that $X^2_{calculate}$ on both sample groups was smaller than the X^2_{table} on related group samples. Thus, it can be concluded that the data distribution score of understanding on the mathematical concept for both samples was normal.

Next, the homogeneity variance calculation result data of understanding on the mathematical concept of the students was conducted with F test. According to the calculation result, it obtained $F_{calculate}$= 1,084 and F_{table}= 1,726. If both of these data calculations were compared to each other, it showed that $f_{calculate}$ was smaller than f_{table}. So, it could be concluded that both of the samples were homogenous. Since the normality and homogeneity requirements were fulfilled, so it could be done hypothesis test using one tail T-test. The summary of T-Test analysis results can be seen in Table 3 below.

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Tabel 3
The Summary Results of T-Test

Groups	n	dk	$\overline{X}$	$t_{calculate}$	t_{table}
Experiment	39	74	68,667	2,725	1,993
Control	37		61,865		

Based on table 3, it showed that $t_{calculate}$= 2.725 while t_{table}= 1,993. By comparison, the $t_{calculate}$ value was bigger than t_{table}. In this case, H_0 was rejected. It meant that the understanding on the mathematical concept of the students who learned with self-assessment was better than the conceptual understanding of the students who learned with conventional learning. Based on the description of the hypothesis test results above, the following discussion could be presented.

From the results of a hypothesis test, it showed that the understanding of mathematical concepts of the students who followed the learning with self-assessment was better than who followed conventional learning. The results of this study were supported by the results of research conducted by Willey & Gardner (2009), Panadero *et al.*, (2012), Honsa (2013) whose the research focused on the use of self-assessment and peer assessment and the results showed that the use of self-assessment and peer assessment had a positive influence on attitudes, motivation, independence, self-efficacy and student learning outcomes, as well as Sugata (2014) who stated that the application of self-assessment could improve students' writing skills. In mathematics, writing is one way of communicating ideas. Mathematical communication is a way of sharing ideas and clarifying comprehension. When students are challenged to communicate their thoughts to others verbally or in writing, students learn to explain, convince, and appropriately in the use of the language of mathematics. With communication, students can connect concepts so that students get the opportunity to develop an understanding of their concepts so that students' understanding of a concept becomes deeper and more lasting.

The difference of this research from the previous research lied in the research variable. The previous research, the variables measured were related to writing skills, while in this study the influence of self-assessment of understanding on mathematical concepts was the subject of the study. The lesson material used in this research was about coordinate system and algebraic operation.

Students' Understanding of mathematical concepts in the experimental group was better because students were trained to monitor, reflect, and make adjustments so that students could understand a concept. In the learning process, students who received mathematics learning by doing self-assessment were given a list of metacognitive on monitoring first, it was aimed so that students could adjust their learning independently. Then, students were given self-assessment criteria which were then set together between teachers and students. In self-assessment criteria, there were steps that could be done by students so that students could understand the concept of a subject matter. The self-assessment criteria were used by the students when the discussion was taking place. Once students were given self-assessment criteria, students began to set their learning goals that led to the learning objectives based on the curriculum according to the teacher's direction. By setting their own learning goals, students became more focused on learning. Students were more likely to seek information and constructed the information obtained to achieve their learning objectives.

Then, the students organizing into heterogeneous learning groups provided good benefits for students. Each group was given LKS (Student Worksheet) which contained some problems that led the students to look for the concept of the material being studied and the problems that required the application of the concept. The questions in the LKS were also related to daily life as well as with other science fields so that students really understood the relevance of the topics that students learned at that time with other topics or with every day's life. During the discussion, the students conducted self-assessment using the self-assessment criteria as guidance in solving the problems given and as a medium of reflection in the problem-solving process. Meanwhile, the teachers used self-assessment criteria that were established with students to guide their observations of the students when students looked for complex problem solutions and used as a reflective material. So during the discussion students read the issues carefully so that students could understand the problems given, solve the problem into sections to find out the information needed to solve the problem, check records, books, and other sources to find ideas that might be useful and the concepts that could be used in solving problems. Then, the students exchanged ideas about the possible concepts used to solve the problem and used objects as a model that could help in solving the problem. This activity was done repeatedly so that students became more independent in learning. By doing these activities repeatedly, the

students knew the various concepts about the material learned and when the concept would be used. By doing self-assessment, students became more confident because students were given the opportunity to assess the learning process. During the discussion, the teacher monitored several students in the group about the steps taken by the students to solve the problem. The teacher had a conversation with the students regarding the steps taken by the student in solving the problem. The teachers also assisted students in understanding how to approach problems so that students were more skilled in monitoring their learning. Thus, the teacher would know the extent of their understanding related to the material learned.

This was also supported by the opinion of Rolheiser & Ross (2005) who said that: "Collaboration will help you more effectively link student learning and instructional approaches for the purpose of continuous improvement". Furthermore, it is about the delivery of discussion results. At the time of result delivery related to the discussion, the teacher selected one of the group members to deliver the group results. When delivering the discussion results, the students were asked to submit the concepts used to solve the issues on the LKS. After that, students from other groups were given the opportunity to respond to the work of their friends. After there was no response from the students, the teacher asked one student to see if the steps and concepts used to solve the problem were correct or not. If the student was able to determine whether the steps are appropriate or not, then the student could assess the understanding of the concept. Students could know their weaknesses and strengthen the material in which the teacher's role could not be separated from this case. This was also supported by the opinion of Kelberau-Berks (2006), and Beaven (in Jehata, 2012) who stated that to know the weaknesses and strengthens in students, it was very important for these students to ask themselves.

Such random student designation could challenge students so that students became more motivated in learning. After that, the students were given feedback regarding the material that had been studied. In the final learning activities, the teacher guided the students to conclude the material that had been discussed and gave little confirmation if there were erroneous conclusions and provided advice in the process of drawing conclusions in their journals. The teachers also invited students to reflect it. In this activity, students wrote down the things they got during the learning activities. Students also wrote things they have not understood, the strength and weaknesses they experienced during learning activities in a journal. The journal was then examined by the teacher and used as a reflective material. In addition, students were asked to compare their learning over time. Then, the teacher gave an evaluation in the form of a quiz to the student to know how far the students' understanding related to the material was while a trained student in determining the right concept to solve a problem. At the end of the lesson, the teacher also always delivered related material that would be discussed at the next meeting so that students could prepare before committing the learning in the classroom.

Learning by doing self-assessment was a learning that conditioned active students the in learning process. Students no longer received information (knowledge) passively from their teacher, students practiced metacognitive skills by self-reflection, self-analysis, interpretation, and reorganization of knowledge. These skills led students to direct their own learning. This lesson emphasized student-centered where students themselves would find concepts, propositions, and others. In the learning process, students could connect things they knew from the problems from the LKS. So, students were trained to understand the material by using their understanding in solving the given problems. Students were also asked to write the conclusions of the materials, weaknesses, and shortcomings in their journals that contained the reflections and insights they gained. The notes in this journal were the evidence of the progress in learning and made the students as independent learners. The journal was used to make improvements in future learning activities. This activity stimulated student learning motivation to get better at the next meetings. Students were required to prepare before the learning process begins. Students also compared their learning over time. This made the students get the right concept with their own activities. As a result, students could understand the concept of the material with more depth. Thus, the mathematical concepts would be more strongly embedded in the students' mind. Their good understanding on what and how to use self-assessment provoked the student to make more effort to apply them (Rolheiser & Ross, 2005) and this result emphasis Ross (2006), Sharma *et al.*, (2016) that the accurate implementation of self-assessment is able to enhance students' enthusiasm, motivation and confidence to learn.

For control classes, the learning used conventional appraisals. The very basic difference between learning in experimental and control classes was during the group discussion and reflection. In the experimental group, students re-established their own learning objectives while students in the control group received only the learning objectives conveyed by the teacher. Whereas, by re-establishing the learning objectives, students became more clear about the things they should look for in learning. Then, during the discussion, the students in the control class did not conduct self-assessment, whereas by doing self-assessment students could monitor and challenge their understanding. There

was no activity to divide the problem given into parts to the control group so the students who followed conventional learning got difficulties in determining which information was necessary and unnecessary. Then, during reflection activities, students in the control group did not write the journal. Whereas, by writing journals, students could monitor more about their understanding related to the material and could strive to improve their learning.

The description above illustrates that learning by self-assessment has a positive impact on students' understanding of math concepts. Therefore, learning by doing this self-assessment can be used as an alternative assessment in the learning of mathematics in an effort to improve students' mathematics learning outcomes and general education quality.

4. Conclusion

Based on the description above, it could be concluded that the use of self-assessment in learning mathematics significantly influenced the students' understanding of mathematical concepts. Therefore, it is suggested to the mathematics teacher to use self-assessment as one of the alternative assessment and hopefully, teachers in designing the instructional plan can give an opportunity to students to conduct self-assessment.

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Statement of authorship
The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

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