THE INTEGRATION OF REALISTIC MATHEMATICAL APPROACH AND VIRTUAL MANIPULATIVE AS AN ENHANCEMENT OF STUDENTS' MATHEMATICAL REPRESENTATION ABILITY

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ABSTRACT

This research is focused on an enhancement students' mathematical representation ability through realistic mathematical approach and virtual manipulative. Then, classroom action research was applied to achieve the objectives of the research. the sample of the research is 30 students of grade VIII-A students of state junior high school SMPN 12 Tanjung Balai. Students' ability was measured by test and observation. To analyze the data, this research used descriptive statistics with five absolute scales, while the data from observation was analyzed based on all aspects examined. After conducting the research, the result showed that students' mathematical representation ability significantly increased which was seen from the data found in cycle I was only 57.9%, while it was going up to 89.5% in cycle 2. In addition, based on the observation against the teachers in operating the virtual manipulative system as teaching aids, the percentage was only 50.6%, and it significantly went up to 84.2%. In short, all the data found meet the benchmark requirements.

Keywords: *Students' Mathematical Representation ability, Realistic Mathematical Approach, Virtual Manipulative*

1. INTRODUCTION

The rapid growth of information and communication technology (ICT) makes a great changes to each aspect of social life (Warsita, 2008). This great changes automatically lead to a huge impact to the quality of education (Mulyasa, 2013). In addition, Hwang, Chen, Dung & Yang (2007) stated that to support students in performing multiple representations for problem solving, ICT tools can be used to better facilitate the learning process. In order to meet the technology ages and education developments, the availability of qualified human resources is urgently needed to anticipate global changes, technology demands, and education requirements (Hasratudin, 2015). In other words, ICT will be an extremely meaningful teaching aids for teaching and learning process in the classroom if the teachers are able to understand, to comprehend, to operate, to explore ICT in the classroom as well as possible (Mulyasa, 2013). This kind of phenomena will be a great challenge for teachers to use ICT in their teaching and learning process in which they are demanded apply ICT and explain the lesson at the same time in order to create a better education quality to the students.

However, the students are prepared to face the globalization challenge as well as the teachers undertake. The students are demanded to have the mathematical skills. There are four mathematical skills needed, they are; critical,

systematic, logical, and creative thinking (Rangkuti, F., Saragih. S., & Hasratuddin, 2014). These ways of thinking can be acquired through a well-structured mathematical learning and a strong definite relationship among its concept so the students have the opportunity to think rationally (Depdiknas, 2003). It shows that math can be defined as a mean of logical thinking so it can be used to solve any problem in daily life (Misel & Suwangsih, 2016). Moreover, Hasratuddin (2015) stated that math is the product of intellectual thinking which comes from any issue related to real daily life. It is also similar with the philosophy of Frudenthal (1977) which defined that the mathematical is human activity. Furthermore, Indonesia government regulation No 19 in 2005 about National Education Standard stated that learning process must be undertaken in interactive, insprirative, fun, and challenging ways in order to motivate the students to participate actively. Porter & hernacki (2013) also stated that active learning process will give a great impact to real life.

It can not be denied that real life always comes along with any life troubles and they can be broken through mathematical skill. One of the mathematical skill needed is mathematical representation ability (Misel & Suwangsih, 2016). Commonly, standard for school mathematics involves some processes, namely; problem-solving, comprehending, involving, communicating and representing (National Teacher of Council of Mathematics, 2000). Mathematical representation ability is being concern since it was added in process standard. Then, it easily makes the students to have that ability (Janvier, 1987; Sierpinska, 1992; Gagatsis, 2004). The term of representation is interpreted as a mean that is used to represent math ideas, such as; tables, graphs, and equations (Confrey& Smith, 1991). It means that represantation can help the students in representing all math ideas so it certainly makes the students understand about abstract-math concepts in daily life.

The research was conducted through observation in grade VIII-A of State junior high school SMP Negeri 12 of Tanjung Balai that showed several matters, namely: 1) the students' mathematical representation ability is still low. The same problem was found in research of Misel & Suwangsih (2016) that showed students of states junior high school 17 Nagri Kaler got lower mathematical representation ability. (2) Math learning process is still far from students' real life. Veloo, Ali, dan Ahmad (2015) also states that Mathematics teacher should use teaching approaches that are able to enchance learning of Mathematics among students (3) the teachers do not use appropriate teaching aids, such as; computer and intenet connection. This kind of teaching aids is knwon as manipulative virtual which can be called as teaching facility, then, all computer program stuffs use virtual representation. (Moyer, Bolyard, Spikell, 2002) explains "any problems mentioned above can be solved by applying the appropriate model of teaching that can improve student mathematical representation ability through some approches that are closest to students' real life and technology-based learning.

In other words, the realistic mathematical teaching models can be applied by using manipulative virtual in order to improve students' mathematical representation ability (Morris, 2013). Students in schools can learn ideas of mathematics through solving contextual problems by applying theory of RME to teach mathematics contents in order to help students recognize the close relationships between abstract mathematics and realistic world (Loc&Hou, 2016). A learning and teaching approach which uses reality as the starting point in the learning and teaching process that aims to support students in building and re-inventing Mathematics through interactive contextual problems (Veloo&Zubainur, 2014). Manipulative help students learn by allowing them to move from concrete experiences to abstract reasoning (Heddens, 1986; Reisman, 1982; Ross and Kurtz, 1993; Hills, 2007), besides,Learning with Virtual manipulative was as effective as with physical manipulative and Virtual manipulative can increase learning enjoyment compared with physical counterparts (Lee & Chen, 2015). Hence, the use of virtual manipulative in math learning is kind of symbols that enables concrete objects becoming abstract objects, otherwise it is allowing them to be a visual objects through dynamic-interactive technology (Switzer, 2015).

1.1. MATHEMATICAL REPRESENTATION ABILITY

Representation is a configuration that definitely can represent an object through some methods. Goldin (Salkind, 2007: 2) states that a representation is a configuration that can represent something else in some ways. It means that representation is certain method that can be used to understand the ideas of math so people will be able to comprehend those ideas. Jones dan Knuth (Hasratuddin, 2015: 123) argues that representation can defined as both model and substitute that represents context and aspect of the problems so the solution can be found easily. Goldin & Shteingold (Salkind, 2007: 4) elaborates two kinds of representation, namely: 1) External representation. This kind of external reperesantation is old-fashioned representation which only used the symbols. 2) internal representation. It is a novel representation which allows people to create something from their thought and it can be used to understand math more easily. In addition, according to Misel & Suwangsih (2016: 31) there are three

indicators of mathematical representation ability, they are; a) visual representation, b) symbolic representation (equation or mathematical expression) and c) verbal representation (written text).

1.2. REALISTIC MATHEMATICAL APPROACH THROUGH VIRTUAL MANIPULATIVE IN LEARNING

Figueiredo, Van, &Gravemeijer (2009) states "students should be given the opportunity to learn mathematics by mathematizing, which includes mathematizing everyday life subject matter as well as mathematizing their own mathematical activity". In other words, studying math will be more fruitful if it is built up from contextual problem experienced by the students. Misel & Suwangsih (2016) investigated the application of realistic mathematical learnin of grade IV students of state elementary school SDN 17 Nagri Kaler in 2014-2015 academic year, the finding showed that students' mathematical representation ability got higher and the student were more active as well.

In details, the stages of realistic mathematical learning which modified by Lestari&Yudanegara (2015) are elaborated as tabel 1 as follows:

Table – 1: The stages of students and teachers' activities in realistic mathematical learning

Stages	Teachers' activity	Students' activity
Understanding contextual problem	• Teacher prepares the condusive classroom and offers the contextual problem to the students which is written in LAS • Teacher act as facilitator who help the students in understanding the contextual problem	• Students are being ready to study, receive, and understand the contextual problems given • Students pay attention to the teacher so they will understand the problems
Solving the contextual problem	• Teacher helps the students to complete the results through giving some questions and guiding them to construct the knowledge relating to the possible model used	• Students work in a group to formulate the appropriate model
Comparing and discussing the finding	• Teacher communicate with the students • Teacher asks each group to present the finding in front of the classroom • Teacher invites other groups to present their results • Teacher gives students opportunity to choose the right model • Teacher explains detailly so the students really understand the formal mathematic concept	• Students have a discussion with other students • Students presents their result in front of classroom • Another students present the different result • Students respond another students' answer written in blackboard, and discuss with others
Concluding	• Teacher asks the students to draw a conslusion • Teacher guides the students to find out the solution	• Students make a conclusion • Students try to find out the right solution

Palvio (2007) said that "Virtual manipulatives can develop students' visualization skills by connecting words, pictures, and symbols simultaneously. This simultaneous presentation can assist students in developing a solid understanding of mathematical concepts". Teachers of mathematics for centuries have helped students understand mathematics using "manipulatives"-- visual objects that help illustrate mathematical relationships and applications. Manipulatives allow students to visually examine, explore and develop concepts (Matti, 2016).

Furthermore, Clements and Mc Millen in (Durmus&Karakirik, 2006) recommended several things considered if the teacher use virtual manipulative, namely:

- Use virtual manipulative to be an assesement as students' reflection to think
- Guide students to change and to reflect their activity, then always predict and explain anything related to the materials.
- Understand the stages of virtual manipulative and able to operate among hardware, software, mathematical content, problem-solving strategy, and so on.
- Use extensible program for long term period for any possible topics.

The teacher should pay a close attention to the things above so the teaching learning process in the classroom will be working very well. One of online site which provides the better virtual manipulative is National Library Virtual Manipulative (NLVM). This site is held by Utah State University and developed through grants from National Science Foundation for over three years. This kind of virtual manipulative has category range until grade K-12 and it is created for mathematic learning (Petti, 2002). In NLVM, the kind of manipulative used is Algebra Tile or block Algebra which consists of some blocks, namely: 1) block squad 2) block *x* and c) blockx^2which can be used as well as flexible.

Here is the example of students' in using virtual manipulative: after getting the result from forming area for each (x+2)(x+2) = 100 then students can use this icon in order to obtain another equation from (x+2)(x+2) is x^2 +4x+4. In details, it is visually shown as **Figure - 1**:

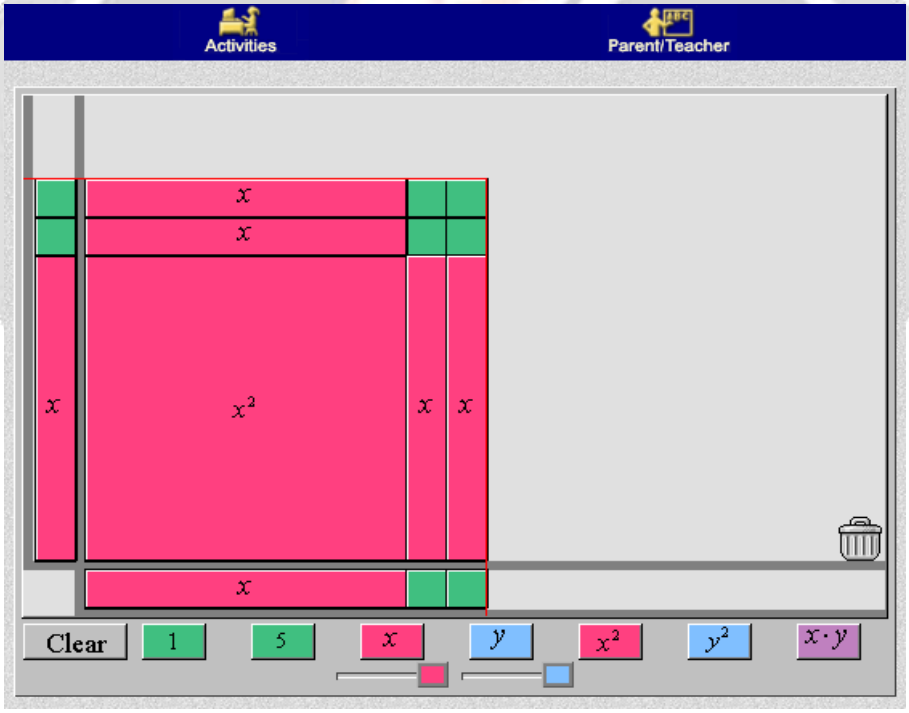

Figure – 1: Stage 3 of Algebra Tile of NLVM

2. RESEARCH METHOD

The method used in the research is classroom action research with qualitative approach. Classroom action research involves some cycles. Each cycle will be implemented with the changes of process obtained. There are four cycles in the implementation of process, namely: planning, action, observing, and reflection. Moreover, there are two cyles used, they are: cycle I and cycle II. In details, the stages of classroom action research based on PGSM project team is clearly shown in **Figure-2**.

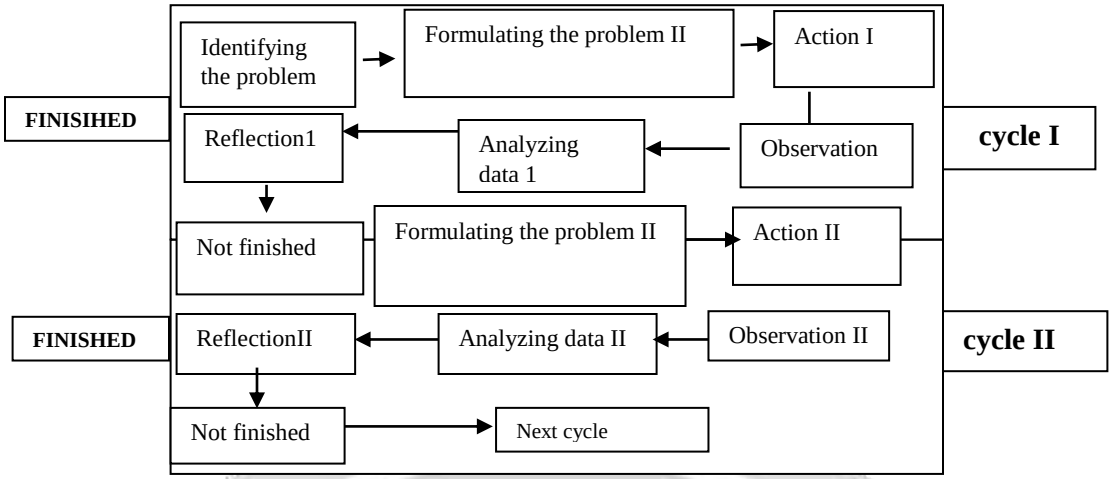

Figure – 2: The stages of classroom action research

3. RESULT

After conducting the research, it is found that students' activity through realistic mathematic approach increases significantly which can be seen both in cycle I and in cycle II. In cycle I, the students' activity in teaching learning process is 50.6% in which the students participated actively in solving the contextual problem given which is related to the indicators of mathematical representation abillity.

In addition, the studens' participation is getting more active in cycle II because the students are allowed to use of teaching aids and media of National Library Virtual Manipulative (NLVM) in Algebra Tile. In this cycle II, each group is exciting to operate the media provided so each group is able to present the contextual problem through abstract form. In short, the finding of the students' participation is visually shown in table 2:

Table – 2: Recapitualtion of Students' Activity in Cycle I and Cycle II

Aspects	Cycle I	Cycle Ii	Explanation
Understanding contextual problem	50%	83.33%	Higher
Explaining contextual problem	52.08%	89.58%	Higher
Solving contextual problem	51.79%	80.95%	Higher
Comparing the answers	41.67%	83.33%	Higher
Concluding	52.08%	81.25%	Higher
Averages	50.6%	84.2%	Higher

Table 2 above shows that students' acitivity is getting higher in each aspect of realistic mathematic approach. While, the increasing of each indicator of students' mathematical representation ability both in cycle I and cycle II can be seen in table 3 as follows;

Table – 3: The Average of Students' Mathematical Representation

Students' mathematical represantation ability	Cycles	
	Cycle 1	**Cycle 2**
Representing visual (picture)	75.44%	86.62%
Representing Symbolic (equation or math expression)	53.29%	73.03 %
RepresentingVerbal (written text)	53.95 %	71.71 %

The table 3 above obviously shows that there is the difference between cycle I and cycle II in which the students' ability in representing the math ideas is getting better in cycle II. Besides, the students' mathematical representation taken from previous data to cycle is clearly visualized in table 4.

Tabel – 4: The Percentage of Standards of Mathematical Representation Ability

Standards	**Previous Data**		**Cycle 1**		**Cycle 2**	
	Frequency (f)	**Percentage (%)**	**Frequency (f)**	**Precentage (%)**	**Frequency (f)**	**Precentage (%)**
A	0	0	4	10.53	8	21.05
B	3	7.89	11	28.95	20	52.63
C	9	23.68	12	31.58	7	18.42
D	21	55.26	8	21.05	3	7.89
E	5	13.16	3	7.89	0	0

Furthermore, the percentage of students' achievement taught by mathematicalrepresentation and virtual manipulative media is getting higher as seen as table 5.

Tabel – 5: The Percentage of Students' Passed-Score Standard

Classifications	**Passed**	**Not Passed**	**Totals**
Previous data	23.7%	76.3%	9 students
Cycle I	57.9%	42.1%	22 students
Cycle II	89.5%	10.5%	34 students

The students' virtual representation ability is being higher. It can be seen from the cycle I is 75.44%, while it is 86.22% in cycle II. Then, the students' symbolic representation ability is also getting higher in which it is only 53.95% in cycle I, whereas it has totally increased in cycle 2 which is 73.03%. In addition, the students' verbal representation ability has been increasing from 53.95% in cycle 1 to 71.71% in cycle 2.

The students' mathematical representation has increased based on the standards of mathematica representation ability which is seen from standard A (very good), B (good), and C (not bad). The changes of these standards is clearly seen from previous data to cycle II. While, the standards of D (bad), and E (failed) has decreased in this research. in brief, the use of mathematical approach significantly improve the students' mathematical representation ability.

Then, the data showed that there is only 9 of 38 students who got the passed-scorestandard which is ≥ 65. It means that there are only 9 students or 23.7% who successfully passed the passed-score standard individually, while there are 29 students or 76.3% with the average 50.32 need a more attention to achieve passed-score standard so the students will get that passed-score.

In contrast, after obtaining the research, there is a significant changes which is shown in cycle I in which there are 22 students or 57.9% of 38 students who got standard score. It is slightly shows that the mathematical approach can improve students' mathematical representation ability. Then, it keeps increasing higher in cyle 2 in which there are 34 students or 89.5% have achieved that standard with 80.29 (good), and the rest of students who have not achieved score standard is only 4 students or 10.5%.

4. DICUSSION

After analyzing the data, it can be argued that the integration of realistic-mathematic approach and virtual manipulative media can increase students' mathematical representation ability. Besides, it also help students to have critical, logical, systematic and creative thinkings (Rangktui, Saragih & Hasratuddin, 2014). This kind of learning can be defined as meaningful learning in which it is the key of empowering the students. Theoritically, David Ausubel (Budiningsing, 2005; Ruseffendi, 2006) was the first one who claimed meaningful learning. Then, Ems dkk (2005) named it with other terminology which is natural learning. There are three characteristics of natural learning,namely: 1) learning will be more natural if it is meaningful, 2) student can apply what they learn in daily life, and 3) students are able to elevate the personal qua;ity through solving the problem occured in the real life.

The mathematical representation ability can be applied with virtual manipulative in this research. The similar research conducted by Misel & Suwangsih (2016) was found that the application of realistic mathematical learnin of grade IV students of state elementary school SDN 17 Nagri Kaler in 2014-2015 academic year, the finding showed that students' mathematical representation ability got higher and the student were more active as well.

In addition, Reimer & Moyer (2005) investigated the students' learning process of division materials taught by virtual manipulative in two weeks and the finding showed that most students got higher score than before, and the students understand about the math concept very well. Shortly, virtual manipulative significantly affects students' math skill.

Lastly, the finding of this research is also supprted by Bolyard & Moyer (2006) who found that 99 students of grade six had significant improvement in addition materials taught by using virtual manipulative. In brief, virtual manipulative certainly is able to help the students in understanding math concepts.

5. CONCLUSION

After analyzing the data, some conlusions are drawn in the following:

1. There is a great enhancement of the integration between realistic math approcach and virtual manipulaitve in math teaching-learning process. It is slightly showed from observation which was conducted from cycle 1 and cycle 2. Firstly, the understanding of conetxtual problem In cycle 1, the percentage was only 50%, while it is getting higher which was 83.3% in cycle 2. Secondly, the representing contextual problem in cycle 2 was51.79%, and it was extremely higher in cycle 2 which was 80.95%. thirdly, the comparing the answers of contextual problem in cycle 1 was 41.67%, then in cycle 2 it was going up to 83.33%.
2. The use of realistic mathematic approach automatically affects to the students' mathematical representation ability. It can be seen from the data found that passed students in cycle 1 were only 22 students (57.9%), while it had been moving up to 34 students (89.5%) in cycle 2. Then, the increasing was also seen frome each indicator available in which the visual representation ability was only 73.03% in cycle 1, and cycle 2 was 75.44%. Last, students' verbal presentation was only 53.95% in cycle 1, and it significantly went up to 71.71% in cycle 2.

6. SUGGESTIONS

In relation to the conclusions above, some suggestions are offered, namely

1. The integration of realistic mathematics model and virtual manipulatice offers an alternative models of teaching in order to increase students' mathematical representation ability., though, some teacher will face some difficulties in both grouping the students and creating the conducive classroom.
2. The teachers will find out some difficulties in explaining the using of virtual manipulative to the students properly. Teacher needs to have a lot of time to make the students are familiar with virtual manipulative as teaching aids.

3. The use of virtual manipulative do not only give a great effect to the students' mathematical representation ability, but it also allows students to have positive thinking againts mathematic, so the students enjoy each math learning process, then, the students are motivated to use virtual manipulative as media used both at home and at school.

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