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The Effect Of Revised Bloom's Taxonomy On Mathematical Problem-Solving Skill

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***Abstract*— The purpose of this research is to show the effect of teaching story problems using revised Bloom's taxonomy on mathematical problem-solving skill. The research uses an experiment method with Randomized Post-Test Only Control Group Design. The sample includes 60 eight-grade students selected through simple random sampling. Data are analyzed by applying t-test to test mean difference previously analyzed using descriptive statistics and data requirements analyses. The normality test uses chi-square test, while the homogeneity test uses Fisher's exact test. Hypothesis test shows $t_{observed}$ of 6.55 and t_{table} of 2.00, meaning that H_o is rejected. The results show that mathematical problem-solving skill of students taught story problems using revised Bloom's taxonomy is better than those taught using solo taxonomy. In conclusion, there is a significant effect of teaching story problems using revised Bloom's taxonomy on mathematical problem-solving skill of students.**

Keywords— Learning, Revised Bloom's Taxonomy, Problem-solving Skill

I. INTRODUCTION

Education is an effort to develop human resources and to shape nation's characters. Therefore, in this increasingly modern era in which the quality human resources in various aspects are certainly needed, it is only education that can produce them. In other words, the success of a nation starts from the education that can produce quality human resources. However, even though most Indonesian education has been carried out in schools categorized as formal education from SD/MI, SMP/MTs, SMA/MA to university, it still faces even a greater global challenge. Considering that, it should be an encouragement to students to get the best achievement at both national level and international level. But, in fact, the achievement Indonesian students get in international arena is still very low.

Director of The National Development Planning Agency (Bappenas), Subandi Sardjoko stated that based on data from *United Nations Development Program* (*UNDP*) 2011, Indonesian Human Development Index (IPM) is ranked 124th out of 187 surveyed countries with index of 0.67 percent. As for Singapore and Malaysia, they have higher indexes of 0.83 percent and 0.86 percent respectively. Besides, index of high education level in Indonesia is also considered to be low of 14.6 percent compared to Singapore and Malaysia that have had better education level indexes of 28 percent and 33 percent respectively. Therefore, it is highly important to further evaluate the factors causing low competitiveness of Indonesian students at internasional level.

Further, one of the efforts to improve the quality of current Indonesian education is by issuing Law No. 20/2003 on the National Education System. Its enforcement is then supported by the issuance of the National Education's Ministry's regulation (Permendiknas) No. 22/2006 on standard contents of mathematics explicitly mentioning that mathematics is taught with the aim of providing students with skill in thinking logically, analytically, systematically, critically and creatively and with skill in cooperating. It applies to mathematics because mathematics is a subject regularly taught at every education level. The objective of teaching mathematics for elementary and high schools is to provide students with skills in: (1) understanding mathematical concept by explaining the relation between the concept and its application flexibly and accurately and solving problems efficiently, (2) using reasoning in their behavior and character and mathematical manipulation in generalizing, finding proofs or explaining mathematical ideas and statements, (3) solving problems involving skills in understanding mathematical problems, designing and completing the solution models and then interpreting the obtained solutions, (4) communicating ideas, symbols, table, diagram or other media to explain condition or problems, (5) appreciating the usefulness of mathematics for life by showing curiosity about, passion for and interest in learning mathematics as well as seriousness and confidence in solving problems. Mathematics is taught with the hope that students can sharpen thier skill in thinking, arguing, negotiating and solving problems in both learning activities and daily activities [1].

Problem-solving is very an important aspect in mathematics learning and development processes. Accordingly, teaching mathematics at schools should focus on the improvement of students' skill in solving mathematical problems including aspects of conceptual/procedural knowledge, strategy, communication, and accuracy. The problem-solving can also help to increase intellectual potential and confidence of students. Nevertheless, there are still many problems concerning mathematical problem-solving skill of students. Even though most people recognize the importance of mathematics, it is only small number of them who understand what mathematics actually is. Mathematics is considered as the set of rules to be understood, arithmetical calculations, mysterious algebraic equations and set of formulas to be memorized. It is as seen

in the low achievement of Indonesian students' in mathematics. It shows that the skill of Indonesian students' skill in mathematics is still dominant at a low level.

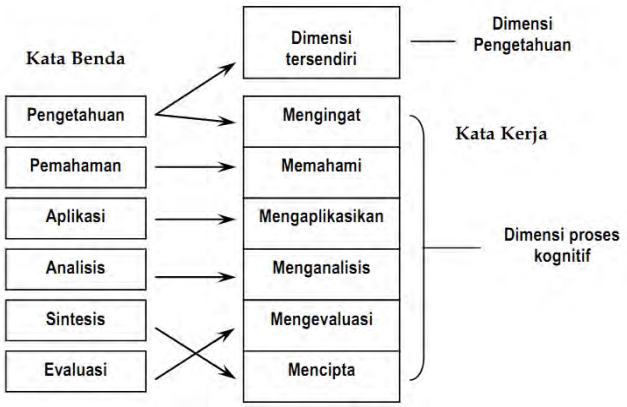
According to data from Balitbang Kemdikbud [2], the mathematical skill of Indonesian students is still far below international median, meaning there are no Indonesian students reaching advanced standards, with 2% high level achievement, 15% intermediate level achievement and cumulatively 43% low level achievement of Indonesian eight-grade students in mathematics. Considering the above problems, teachers should be able to choose and apply learning strategies that can encourage students to be more active in learning mathematics, so that the teaching objectives can be well accomplished, with students being able to solve story problems in mathematics. It is one of reasons why constant reforms in the education sector are necessary to improve the quality of national education. The reform can be made by applying Bloom's taxonomy. It is in accordance with the mandate of the curriculum 2013 stating that the essence of a scientific approach in learning is believed to be a golden platformfor developing attitude, skill and knowledge of students

II. REVISED BLOOM'S TAXONOMY

As teachers involving in education, we are very familiar with Bloom's taxonomy. In online KBBI (kbbi.co.id), taxonomy is defined as a classification of science; rules and principles covering the object classification. In the taxonomy introduced by Benyamin S. Bloom in 1956, there is a reference that can be used by teachers to formulate the objectives of learning and to choose the learning method and evaluation to be implemented. Bloom classifies the objectives of education into three domain (realm, area). Each domain is then divided up in more detail by its hierarchy. The three domains classifying the objectives of education are:

1. Cognitive Domain, comprising things that must be known (intellectual aspect) and the function of processing information, knowledge and mentality skills, such as knowing, understanding and thinking skills.
2. Affective Domain, consisting of behaviors emphasizing the aspects of feeling and emotion, such as interest, attitude, intention, apreciation, recognition, enthusiasm, motivation and self-adjustment. This domain is related to taste, like or dislike, care or not care and so on. Mentions that "affective domain covers receiving, responding, valuing, internalizing values and organization".
3. Psychomotor Domain, involving behaviors emphasizing the aspect of motor skills like having handwriting, typing, swimming and operating machines. This domain is related to human physical ability and manipulative ability to control his body organs. Psychomotor domain includes perception, set, guided response, mechanism, complex overt response, adaptation, origination.

Although divided into three domains, they can not be separated one another. Those domains form a certain set of skills. Each of them is further divided by Bloom into some sequentially hierarchical categories and subcategories, ranging from the simple to the most complex ones. [3] states "The Cognitive domain of Bloom's taxonomy often serves as a framework for categorizing objectives of education, designing tests, and designing curricula." Bloom divides up a cognitive domain into 6 categories, namely: knowledge or C1, comprehension or C2, application or C3, analysis or C4, synthesis or C5, dan evaluation or C6. However, as time goes by, the concept undergoes revision and is named revised Bloom's taxonomy. The revision was made by one of Bloom's students, Lorin Anderson in the late 1990s and was published in 2001. The change from original mindset to the revision is presented as the following.



Picture 1. Change from Original to Revised Mindset [3]

The picture above shows the change of taxonomy from a noun (original taxonomy) to a verb (revised taxonomy). The points of Bloom's Revised Taxonomy as stated are:

1. From one dimension into two dimensions (dimension of knowledge in old taxonomy is divided up into dimension of knowledge and dimension of cognitive process in revised taxonomy)
2. Dimension of knowledge (dimension of knowledge in old taxonomy only consists of three basic categories, while in revised taxonomy, it consists of four basic categories)
3. Dimension of cognitive process. it consists of same 6 categories, but, there are some important changes such as name, form from a noun to a verb and position.
4. Table of taxonomy. Division of one dimension of old taxonomy into two revised dimension of taxonomy creates a relation between dimension of knowledge and dimension of cognitive process that can be presented in a taxonomy table.

The results of education are disseminated to and accepted by environment as an input used based on their functions. It can be said that learning is a change in students' quality of

cognitive, affective and psychomotor skills to raise their standard of living as an individual, society and being of God Almighty.

III. METHODS

The research is conducted at SMPN 18 State Junior High School located on Jalan Menteng Kecil, Kebon Sirih, Menteng, Jakarta Pusat, Jakarta. The research time is an even-numbered semester in 2017/2018 Academic Year starting from April to July 2018. The research uses an experimental method. Resarch design used in the research is Randomized Post-Test Only Control Group Design. Every group is chosen randomly. Treatment in the form of application of revised Bloom's taxonomy in learning story problems (X) is given to the first group later called experimental group, while treatment in the form of application of solo taxonomy is given to the second group, called control class. The research design is presented as follows:

Group	Treatment
R(E)	X_E
R(K)	X_K

Picture 2. Research Design

Details:

E	:	Experimental class taught using revised Bloom's taxonomy
K	:	Control class taught using solo taxonomy
X_E	:	Treatment in experimental class taught using revised Bloom's taxonomy
X_K	:	Treatment in control class taught using solo taxonomy
Y_E	:	Mathematical problem-solving skill in experimental class taught using revised Bloom's taxonomy
Y_K	:	Mathematical problem-solving skill in Control class taught using solo taxonomy

Accessible population in the research is all eight-grade students of SMPN 18 Jakarta 2017/2018 Academic Year, with research samples as many as 60 students consisting of 30 students of experimental class and 30 students of control class. Post test data on mathematical problem-solving skill of students are analyzed by employing a descriptive analysis technique. Data analysis requirement tests used are chi-square test on normality test and F test on homogeneity test. The hypothesis test is performed using t-test for 2 data groups.

IV. RESULTS AND DISCUSSION

A. *Results of Research*

Descriptive statistics data based on the calculation results are presented as the following:

Table 1
Summary of Descriptive Statistics

Statistics	Experimental Class	Control Class
Total sample	30	30
Mean	78.4	67.67
Median	79.5	68.07
Mode	81.77	68
Standard deviation	6.96	5.67
Variance	48.39	32.16

The table 1 shows a quite large difference between the experimental class and the control class, indicating that teaching materials using revised Bloom's taxonomy and solo taxonomy has a positive effect on mathematical problem-solving skill of students. It also shows that the mean of the experimental group is bigger than the control group. In addition, there are far more students of experimental group receiving bigger test scores than that of control group. Before conducting hypothesis test, we must first carry out the normality test and homogeneity test. The following is the table of summary of normality test and homogeneity test.

Table 2
Summary of Normality Test Results

Class	Total sample	$\chi^2 observed$	$\chi^2 table$	Conclusion
Experimental	30	6.43	11.07	Both data groups are normally distributed
Control	30	4.73	11.07	

Table 3
Summary of Homogeneity Test Results

Class	Total sample	Variance	F observed	F table	Conclusion
Experimental	30	48.39	1.50	1.85	Both data groups are homogenous
Control	30	32.16			

The table 2 shows that $\chi^2 observed$ for experimental group and control group are smaller than $\chi^2 table$ with $\alpha = 0{,}05$. It indicates that each group has normal distribution of scores. As for table 3, it shows that $F_{observed} = 1.5 < F_{table} = 1.85$, showing that data are from homogenous population. After conducting analysis requirement test, it continues with hypothesis test. The

following is the recapitulation of the hypothesis test calculation results:

Table 4
Recapitulation of Hypothesis Test Calculation Results

Group	Total sample	Mean	$T_{observed}$	t_{table}	Conclusion
Experimental	30	78.4	6.55	2.00	H_o rejected
Control	30	67.67			

B. Research Result Discussion

Based on data analysis with $\alpha = 0.05$, it can be seen that the value of $t_{observed} = 6{,}55 > t_{table} = 2.00$, meaning that H_o is rejected. In other words, the average mathematical problem-solving skill of students taught using revised Bloom's taxonomy is better than that of students taught using solo taxonomy. So, it can be concluded that there is a significant effect of teaching story problems using revised Bloom's taxonomy on mathematical problem-solving skill of students.

As the guidance for teachers on creating questions, especially story problems, revised Bloom's taxonomy has a very appropriate level to assess the mathematical problem-solving skill of students. Questions arranged from the lowest level to the highest level refer to revised Bloom's taxonomy. The objective is to make students able to solve problems given according to their skill level. The objective at the highest level will not be achieved if the previous level is not fulfilled. This is in line with Efendi's statement in his study of the concept of revised Bloom's taxonomy and its implementation in mathematics. He states that Bloom's taxonomy is a level in identifying students' skills from the basic level to the highest level in revised Bloom's taxonomy bloom made by Kratwohl and Aderson (in Efendi) including remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5) and creating (C6). C4, C5 and C6 levels are often classified as a high order thingking skill level. To make students get used to solving problems, teachers need to develop questions in accordance with Bloom's taxonomy, especially C4, C5 and C6 levels.

With teaching mathematics using revised Bloom's taxonomy by teachers, students' mindset of activities can be adjusted based on their condition in a classroom. It makes students understand, remember and then think higher. According to Heong et al. in [4] high level thinking skill is defined as the wide use of mind to find new challenges. The high level thinking skill requires someone to apply new information or previous knowledge and to manipulate information to find possible answers in new situation. The revised Bloom's taxonomy is very useful when teachers plan learning and organize thinking skill into 6 levels, from the lowest one to the highest one. With students being used to answering the questions, related to the students' needs to solve problems in their daily life, it is expected that the problem-solving skill of students can optimally fulfill the learning objectives.

V. CONCLUSION

From the the problem statement, the research results and the discussion, it can be seen that the average mathematical problem-solving skill of students learning using revised Bloom's taxonomy is better than those learning using solo taxonomy. In conclusion, there is significant effect of learning story problems using revised Bloom's taxonomy on mathematical problem-solving skill of eight-grade students of SMPN 18 Jakarta, 2017/2018 Academic Year.

Recommendations that can be implemented based on the results of the research are: (1) learning at schools should focus on student-centered approach in an effort to make students more active in the learning process, especially in the process of developing their mathematical problem-solving skill; (2) Teachers should be more creative in presenting exercises containing daily life problems in accordance with revised Bloom's taxonomy levels, so that the students can develop their skill in solving problems and can acquire meaningful knowledge; (3) Similar researches should be able to apply other approaches to improve the mathematical problem-solving skill of students in mathematics.

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