

The Effectiveness of Problem-Based Learning Approach Based on Multiple Intelligences in Terms of Student's Achievement, Mathematical Connection Ability, and Self-Esteem

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Abstract. The aim of this study is to explore the effectiveness of learning approach using problem-based learning based on multiple intelligences in developing student's achievement, mathematical connection ability, and self-esteem. This study is experimental research with research sample was 30 of Grade X students of MIA III MAN Yogyakarta III. Learning materials that were implemented consisting of trigonometry and geometry. For the purpose of this study, researchers designed an achievement test made up of 44 multiple choice questions with respectively 24 questions on the concept of trigonometry and 20 questions for geometry. The researcher also designed a connection mathematical test and self-esteem questionnaire that consisted of 7 essay questions on mathematical connection test and 30 items of self-esteem questionnaire. The learning approach said that to be effective if the proportion of students who achieved KKM on achievement test, the proportion of students who achieved a minimum score of high category on the results of both mathematical connection test and self-esteem questionnaire were greater than or equal to 70%. Based on the hypothesis testing at the significance level of 5%, it can be concluded that the learning approach using problem-based learning based on multiple intelligences was effective in terms of student's achievement, mathematical connection ability, and self-esteem.

1. Introduction

The aim of teaching and learning mathematics mostly focused to derive mathematical concept and skills, while developing the student's ability to recognize and apply mathematical concept in daily life situation was not a priority [1] [2]. The ability to recognize and applying mathematical concept was very important in learning mathematics, in terms of mathematics was a comprehensive and interconnected science which every concept, principle, and procedure are connected each other [3].

The connection in mathematics gives the meaning of learning and provide the reason why students learn mathematics [4]. Therefore, the ability of mathematical connection was very important in learn mathematics.

Build the connection inter ideas will strengthened the students understanding and reduce the pressure of students to memorize and reduce their worrying of forget the materials they have gained [5] [6]. Mathematical connection was students ability to relate the mathematical knowledge and problems they gained in mathematical class with the problems or situations they face in daily life [7]. Mathematical connection was the most important ability to learn mathematics and as one of the process standard of NCTM and one of the aim of learning mathematics in Indonesia[5].



Although the mathematical connection ability is very important, but sometimes school mathematics is seen as something that is not interconnected. This is demonstrated by the textbook, which presents mathematics as a separate and unrelated materials or topics, and yet unfamiliar students in making connections in learning. This fact was causing the ability students's mathematical connection still low.

The study of Anita [8] found that out of 72 middle school students, only 14 students or 19,44% achieve high score of mathematical connection test, 43 or 59,72% of students have score on medium category of mathematical connection test, and 15 or 20,83% of students achieve low score of mathematical connection test. This result shows mostly students get mathematical connection score under high category.

The study of Nurasyiyah [9] showed that the high school students mathematical connection ability to connect some concepts or principles with the problems with other disciplines context or in daily life context only 13,5% of students. Total 35% of students able to applying the mathematical concept to solve the problems in another disciplines context, or daily life context. Instead, the result of prasarvey in January 2016 in MAN Yogyakarta III, showed that less than 50% of students achieve minimum high score in mathematical connection ability test.

Low ability of mathematical connection causes the lack of meaning and interest of students to learn mathematics. It can be seen from a great fear and the lack of attention of students in learning mathematics.

Mostly, students in all levels, from elementary to high school perceive mathematics as a difficult and unattractive subject. The higher of the education level, the more complex of materials of mathematics and requires a process of abstraction. Therefore, more students in high school do not like mathematics.

The fact of lack students interest in mathematics, causes low mathematics achievement of students. Lack of achievement demonstrated by the results of the absorption of the National Examination (UN). One of the material tested in the national examination and has a low absorption is geometry and trigonometry. Based on data from the National Education Standards in 2013, 2014 and 2015, the absorption of students nationwide in the two materials is lower than other materials. One of the schools that have absorption in both the material and lower than the absorption of Sleman, Yogyakarta Special Province (DIY), as well as national level absorptive capacity is MAN Yogyakarta III.

The low of student achievement in MAN Yogyakarta III also demonstrated by the results of Deuteronomy Central Semester (UTS) in 2015/2016. The result of UTS showed that mostly students still have not reached the minimum completeness criteria (KKM), which is 75.

Instead the mathematical connection capabilities as one of the important ability and influence on student achievement in learning mathematics, other aspects that affect student achievement in mathematics is the affective aspect. One of the important affective aspects of the students is self-esteem.

Self-esteem is related to how students see themselves or individual assessments of their capabilities. Self-esteem is the acceptance of individuals against her and that she can vote, deserve to be appreciated, deserves to be successful, and valuable [10] [11] [12]. Self-esteem of the students different from one another. Self-esteem of students can be high, but can also be lower. Tendency, the students with high self-esteem will be more confident in social situations and also in dealing with the tasks assigned by the teacher, while students with low self-esteem tend to prefer punished or may be viewed as a hero by his friends than look stupid [13] [14] [15]. Therefore, it is very important for teachers to pay attention to the self-esteem of students and facilitate students to develop their self-esteem so that students will be more enthusiastic about learning mathematics and student's achievement will be increased.

Self-esteem is closely related to students' attitudes toward mathematics. One indicator of students' attitudes toward mathematics is confidence in the ability of students to learn mathematics. Based Mullis, et al [16], the confidence of students in ability to learn mathematics can be seen from the students' self confidence and self-concept of the student on the ability of students to learn mathematics. In this case the self-concept is closely related to self-esteem. This is corroborated by the

opinion of Lawrence¹⁵, that self-concept can be seen as the term "umbrella" in which there is the self-esteem of an individual.

Based on the results of TIMSS, the scores obtained by Indonesian students related to confidence in the ability of learning mathematics is 9.7, the difference is only 0.3 points from the lowest score, namely 9.4 [16]. The result of TIMSS shows that the self-esteem of students Indonesia relating to confidence in the ability in mathematics is still low. Low self-esteem of students in learning mathematics, especially in MAN Yogyakarta III also obtained from the prasurvey conducted by investigators in January 2016. Based on the results of prasurvey, only 3,3% of students in very high category of self-esteem, 43,3% in the high category, 50% in the medium category, and the remaining 3,3% are in the low category. Therefore, teachers need to build community in the classroom, where each student will recognize and be actively involved in learning process.

Based on the description that has been described, the teacher must design learning that can develop the achievements, the mathematical connection ability and self-esteem of students in the learning mathematics. One approach of learning that can be used is the Problem-based learning (PBL). One of the characteristics of PBL is to provide a problem that close to real life and may occur in real life, so that PBL is a solution to facilitate the students to perform connection process between the material to real life. PBL allows students acquire new knowledge or solve problems tightly everyday life [17].

The advantages PBL in developing students' mathematical connection ability is also supported by the results of study. Based on the study conducted by Ratnaningsih [18], it showed that the students who received problem-based learning tend to obtain a significant increase in the ability of connections compared to conventional learning. In addition based on the results of study, PBL chosen because it has some of the following characteristics: 1) presents a problem that close to real life and may occur in real life, 2) encourage the students are engaged in learning activities, 3) encourage the use of various approaches, 4) allow students to make a choice about how and what will be learned, 5) to encourage collaborative learning, and 6) help achieve a quality education [17].

PBL is a constructivist learning approach with many advantages may still have a problem for some students who do not have an interest in mathematics. Teachers need to consider the potential of the students, one of the potential is intelligence. According to Gardner [18] each individual has all the capacity and intelligence with different combinations. Gardner stated that there are nine types of intelligence, such that intelligence linguistic, musical, logical-mathematical, spatial, kinesthetic, intrapersonal, interpersonal, naturalistic, and existential. Thus intelligences was called multiple intelligences. The theory of multiple intelligences believe that every student is unique, and at least have one intelligences [19] [20].

The diversity of intelligence of students does not mean that teachers should conduct learning activities individually, but the diversity of intelligence of students should be used as capital for a teacher to develop methods of learning and develop learning tools in order to facilitate the students through multiple intelligence possessed by the student [21]. By implementing multiple intelligences in the learning process will make students feel recognized in the classroom and students will better appreciate its intelligence [22]. Learning mathematics attention will make students feel recognized in the classroom and students will appreciate the intelligence they have and make the students realize how smart they are, that is where it can make the students develop self-esteem and self-confidence of students [23] [24]. In addition, the results of research which are carried out by Al-Zyoud and Nemrawi [25] that the class that implements the intelligences multiple in the learning process gives better results in the development of self-concept than students in classes that do not use multiple intelligences.

Based on the description that has been presented, learning with PBL approach by taking into account the multiple intelligences of students are expected to develop the achievements, the mathematical connection capability, and self-esteem of students in the learning of mathematics. Therefore, it is necessary to study on the effectiveness of problem-based learning approach based on multiple intelligences in terms of achievement, the mathematical connection ability, and self-esteem of students.

2. Research Method

2.1. Type, Time, Place, and Research Sample

This study was a quasi experiment. This study conducted in MAN Yogyakarta III from April until May 2016. The population of this study was all students of grade X of MAN Yogyakarta III. The sample of this study was grade X students of MIA 3 of MAN Yogyakarta III.

2.2. Research Procedure

This study began by providing a self-esteem questionnaire before learning process. In the implementation of learning through problem-based learning approach based on Gardner's multiple intelligences used the learning kits, consist of lesson plans and worksheets. Before preparing lesson plans and worksheets, researchers first identified the tendency of intelligence of students by distributing questionnaires tendency of intelligence, where the results are used for several things, including: preparing lesson plans and worksheets, arrange some activities based on multiple intelligences, and arrange group of students with heterogeneous intelligence. Lesson plans using PBL approach based on Gardner's multiple intelligences having learning steps as follows: (1) Teacher orient students to the problems in diverse contexts to encourage all students actively involve in learning process; (2) Teachers organize students to learn; (3) Students identify the problems and analyze the data individually or in a heterogeneous group; (4) The students presented the results in different ways; (5) The teacher and the student are evaluate the problem solving process. While the worksheets have a variety activities based on multiple intelligences, also there are some connection problems to help students to develop their connection ability, and some "quote of the day" to help students develop self-esteem. The developing teaching kit fulfill the validation criteria based on the results of expert judgement which is respectively obtaining average score 4.54 and 4.43 out of a maximum score of 5.

The instrument used in this study was a self-esteem questionnaire, achievement test and mathematical connection ability test. Based on the validity of the content, all three instruments are valid.

Instrument reliability of students' self-esteem questionnaire is 0.901 with SEM 1.38. The estimation results of the reliability of test achievement on trigonometry and geometry of the material can be seen in Table 1 below.

Table1. The reliability of Achievement Test

No	Instruments	Reliability	SEM
1	Achievement test of Trigonometri	0,784	1,807
2	Achievement test of Geometry	0,847	1,835

2.3. Data Analysis Technique

Data analysis techniques consisted of descriptive analysis and statistical analysis. Descriptive data are translated based on the average, maximum score, and minimum score. The learning approach satisfied effectiveness criteria if the percentage of students who get minimum criteria of achievement test, and achieve minimum category of mathematical connection test and also in self-esteem questionnaire are greater than or equal to 70%. Statistical analysis using the proportion test of the result of achievement test, mathematical connection test, and self-esteem questionnaire. The learning approach effective if at the significance level of 5%, the proportion of students who achieve minimum criteria of achievement test, also achieve minimum category of connection test and self-esteem questionnaire are greater than or equal to 70%.

3. Result and Discussion

The result of achievement test are presented in Table 2 below.

Table2. The Description of Achievement Test Result

No	Description	Score of Achievement Test
1	Average	77
2	Percentage of Students Completeness (%)	86,7

Tabel 3 and Table 4 respectively present the proportion of students of the result of mathematical connection test and self-esteem quistionnaire.

Table3. Mathematical Connection Test Result

No	Criterion	Number of Students	Precentage (%)
1	Very High	21	70
2	High	4	13,3
3	Medium	5	16,7
4	Low	0	0
5	Very Low	0	0

Table 4. Self-Esteem Questionnaire Result

No	Criterion	Number of Students	Precentage (%)
1	Very High	4	13,3
2	High	22	73,3
3	Medium	4	13,3
4	Low	0	0
5	Very Low	0	0

Based on Table 2, was obtained that based on achievement test result, the percentage of students who achieve score in minimum KKM was 86,6%. Table 3 and Table 4 respectively shows that the percentage of students who achieve score in minimum high cathegory of mathematical connection test and self-esteem questionnaire was 83,3% and 86,6%. The data obtained are the data that came from normal population based on normality test result. The percentage of each test used to test the proportion to find how significant the result of each test.

The next phase was performing the proportion test of student's achievement test, mathematical connection test, and self-esteem result. Based on the proportion test of achievement test obtained the Z-value 2,092 Z-table, which $Z_{0,05} = 1,645$, it concluded that H_0 rejected. At the signifcant level 5%, it can be concluded that the problem-based learning approach based on Gardner's multiple intelligences was effective in terms of learning achievement.

This result shows that problem-based learning based on Gardner's multiple intelligences could develop the students achievement. The result appropriate with the study of Al-Zyoud and Nemrawi[25]about the effectiveness of multiple intelligences theory and the result shows that there is the significance difference between the experiment class and the control class in terms of students achievement.

Even the result was good, still there are some problems which achieve under 70% students who make correct answers. One of the problem of achievement test was number 11 on trigonometry, which achieve 20%. The problem shows in figure 1 below.

11. Seorang pengendara sepeda *downhill* menuruni sebuah bukit yang memiliki ketinggian h . Jika kemiringan bukit adalah $20,2^\circ$ dan pengendara tersebut membutuhkan waktu 10 menit sampai ke bawah dengan kecepatan tetap 60 km/jam, Rumus trigonometri yang sesuai untuk mencari tinggi bukit adalah
- A. $10 \times \cos 20,2^\circ$ D. $600 \times \cos 20,2^\circ$
 B. $10 \times \sin 20,2^\circ$ E. $600 \times \sin 20,2^\circ$
 C. $10 \times \tan 20,2^\circ$

Figure 1. Achievement Test of Trigonometry

The result of students work on problem number 11, 13.3% of students answered A, 20% of students answered B, 6.7% of students answered C, 6.7% answered D, and 53.3% answered E. Mostly students choose E, namely $600 \times \sin 20,2^\circ$. Most likely the students answered E due to an error in determining the distance rider. The distance calculation used should $60 \text{ km} / h \times 10 = 600$. The correct calculation is first change the number of minutes in an hour, so $10 \text{ minutes} = \frac{1}{6} \text{ hour}$, so that the correct distance is $60 \text{ km} / h \times \frac{1}{6} h = 10 \text{ km}$. The correct answer to question number 11 was B.

Furthermore, based on the proportion test of mathematical connection test results, obtained Z-value was 1,697 where the value is greater than from Z table, which is $Z_{0,05} = 1.645$, so H_0 rejected. Then, at a significance level of 5%, it can be conclude that problem-based learning approach based on Gardner's multiple intelligences effective in terms of mathematical connection test results.

These results correspond with the results of study of Sumarmo and Permana[18]. The results showed superiority of experimental group, which is group with problem-based learning approach than the control class. On the implementation of learning by problem-based learning approach based on Gardner's multiple intelligences of students accustomed to practice solving the problems associated with other topics, everyday life as well as those related to other disciplines in diverse contexts, so that students are accustomed to make a connection. In addition, student learning is given a few questions to choose the procedure used or concepts used in solving the problem. It is appropriate to[26], that in order to assist students in making connections and help the to develop their thinking, judging conclusions, strategies and procedures used. Although the mathematical connection test results have been good, but there is a number that have low achievement, which is a connection problem of number 2. In which from 30 students, only five students who answered correctly. Based on the interview, mostly students find the problem at number 2 was too difficult.

Furthermore, the proportion test of the result of self-esteem questionnaire obtained $Z = 2.092$ greater than $Z_{0,05} = 1.645$, so that H_0 rejected. At the 5% significance level, learning by problem-based learning approach based on Gardner's multiple intelligences effective in terms of students self-esteem. This is consistent with the notion that multiple intelligences based learning makes students realize how smart they are, that is where it can make the students develop self-esteem[17].

These results are also consistent with the results of Rafianti study[26] that students who join in the learning based on Gardner's multiple intelligences a high self confidence. This study is relevant because the self-esteem and self-confidence are interconnected. belief or confidence (self-confidence) that the person is capable of performing the task can raise self-esteem or self-esteem[10]. Moreover, the results indicate that self esteem scores for all items increased, and there are three item questionnaire highest increase, ie item numbers 7, 8, and 17. Where the item number 7 and 17 refer to the indicator of self-esteem about showing confidence of being acceptable by others, while the item number 8 respect to the indicators of self-esteem about understanding the self. The increase was made possible due to the application of the theory of multiple intelligences, which gives students the chance to learn in a variety of different ways, and the activities of the group in which one group is composed of some intelligence, so that each student can be actively engaged in learning, and feel valued.

4. Conclusion and Suggestion

At the 5% significance level, learning by problem-based learning approach based on Gardner's multiple intelligences effective in terms of student's achievement, the mathematical connection capability, and self-esteem of students. However, although there are some problems have been effective on achievement tests and mathematical connection test result which have low achievement. While some of the items on the self-esteem questionnaire having high improvement, which is possible because the learning that take account of students' diversity as one of the characteristics of the multiple intelligences theory that led the students felt more appreciated in learning.

Therefore, it is advisable for teachers to use problem-based learning approach based on Gardner's multiple intelligences in the learning process of mathematics. For the next researcher is expected to consider the difficulty level of the problems in order to obtain better results.

5. References

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