STUDENTS’ MATHEMATICAL PROBLEM SOLVING ABILITY AND DISPOSITION USING CONTEXTUAL TEACHING AND LEARNING APPROACH

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ARTICLE INFO

Article history:
Received Feb 27, 2021
Revised Mar 03, 2021
Accepted Mar 05, 2021

Keywords:
Mathematical Problem Solving
Mathematical Disposition
Contextual Teaching and Learning

ABSTRACT

The aim of this study is to analyze the role of contextual teaching and learning (CTL) approach on students’ mathematical problem solving ability (MPSA) and disposition (MD). The study is a pre-test post-test experimental control group design, that involved 40 tenth grade students of Madrasah Aliyah in Bandung, that were chosen by purposive sampling technique. The instruments used in this study consisted a mathematical problem solving test (4 essays) and a mathematical disposition scale (26 statements). The study found that on MPSA, its normalized gain and on MD students getting treatment with CTL attained better grades than grades of students taught by conventional teaching. Even though both students’ grades on MPSA were still at a very low level, but first group students’ grade on MD was at a medium level and the second group students’ grade was at a low level. Many students still experiencing difficulties on compiling MPSA. The other findings, there was no association between MPSA and MD, but students performed good perception toward CTL approach.

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How to Cite:

INTRODUCTION

Based on limited observation when researchers visit to a mathematics lesson class in one of Madrasah Aliyah (MA) in Bandung, we found that most of the students able to solve simple mathematics problems without any difficulties. Even though, when students met non-routine mathematics story problem, some students were not able to solve it. They did not know how to begin to solve the problems. They are confused and worried, moreover they avoid to solve such kind of problems. However, some other students try to solve the problem, despite they should work harder and it takes a longer time. The students try to identify the known data and unknown data, and then they relate them into mathematical model and solve it. They felt enthusiastic to solve the unusual mathematics problem. The first case illustrated students’ condition with low mathematical ability and low disposition. While the second condition illustrated students’
condition with high level mathematical problem solving ability (MPSA) and disposition (MD). However, those conditions are a normal situation in mathematics teaching and learning. Even though, teachers should still attempt to help students to overcome their difficulties on solving the non routine mathematical problems, such as mathematical problem solving (MPSA) tasks.

In fact, mathematical problem solving ability (MPSA) is essential mathematics ability that should possess by and be improved on junior high school students. Some reasons found that statement among other things is MPSA is attached in the goal of mathematics teaching (Departemen Pendidikan Nasional, 2013, NCTM, 2000). Furthermore, the importance of possessing MPSA by students is in line with Branca’s conception (1980, as cited in Sumarmo, 2010) namely: Mathematical problem solving constitutes main process in the goal of teaching-learning mathematics, moreover it is basic ability and the heart of mathematics.

Polya (1985) proposes that problem solving is an effort to seek way out from a case which not easy to solve. So, when the student is going to solve an unusual problem or problem solving task, he or she should have strong desire and motivation for solving it, and he or she believes will succeed in other mathematics task as well. Having desire and strong motivation for learning will help student not easy to give up when he or she meets with difficulties. That situation illustrates a positive attitude on mathematics learning and it is called as mathematical disposition (MD). Student who has high order mathematics thinking such as MPSA usually has high MD as well. But not conversely. It means that MD constitutes as a prerequisite for mastering MPSA.

As an implication of that statement, it is rational that one of mathematics teacher’s task is to improve student’s MPSA and MD accordingly. In fact, this implication is in line with suggestion of mathematics curriculum (Departemen Pendidikan Nasional, 2013). A kind of innovative mathematics teaching-learning approach which conform to suggestion of Kurikulum 2013 is contextual teaching and learning (CTL). Ibrahim (2011) and Johnson (2010) propose different conception about CTL, however they illustrate a teaching-learning approach wich start with presenting a relevant contextual problem for obtaining concept understanding and then it is developed in order to master the other higher abilities. The presented contextual problem should relate to the content are going to learn, to the student’s prior ability, and to a real daily life. Johnson (2010) offered some phases in CTL namely: constructivism philoshopy, inquiry, question; learning community, modeling, reflecting, and autenthic assessment. Refering to those activities in CTL, and in MPS and attitudes traits in MD, researchers predict that CTL will conform with our wish.

The afformentioned arguments motivate researchers to carry out a study having a goal to analize the role of CTL on student’ MPSA and MD and formulate problems our study as follow.

1. Are the grades of mathematical problem solving ability, its Normalized Gain (N-Gain) and mathematical disposition of students getting treatment with CTL better than the grades of students taught by conventional teaching?

2. Is there any association between MPSA and MD in CTL class?

3. What kinds of difficulties do students meet in completing MPSA tasks in both classess?

4. What is students’ perception toward the implemented CTL?

Some times, people often think that solving a mathematical problem is similar to completing a mathematical problem solving. In fact, solving a mathematical problem means is to solve general mathematics task from the simplest one up to very complicated mathematical task. While the second term, mathematical problem solving is not simple or routine mathematical task such as Polya’s conception (1985) that to complete a mathematical problem solving is an
effort to seek way out from a case of mathematical problem which not easy to solve. In addition to that, Lester and Kroll (1990) state a problem solving is a task that there is no complete algorithm for obtaining a solution. Krulik and Rudnik (1995) declare that problem solving is a process which an individual uses his or her owned knowledge, skill, and understanding for solving a problem in unknown situation. Thus, a mathematical problem solving is not a simple mathematics task. Refering to the importance of possessing MPSA by high school student, so Departemen Pendidikan Nasional (2013) and NCTM (2000) attach MPSA in the goal of teaching mathematics.

Some experts analyze mathematical problem solving from different point of views. Polya (1985, as cited in Hudoyo, 2003) proposes there were two kinds of mathematical problem, such as: a) Problem for finding theoretically or practically, abstract or concrete; b) Problem for proving that to point out a statement is true, false, or non of them. Other writer, Yee (2005, as cited in Hendriana, Rohaeti, Sumarmo, 2016) classifies mathematical problem into two kinds namely: closed problem and open-ended problem. A closed problem or well-structured problem when it is clear what is be asked, and has only one answer. While open-ended or ill-structured problem when the formula of problem is unclear, or it might be un-complete information, and arises some strategies or some solutions. Further, in sense problem solving as a process, Polya (1985) offers four steps problem solving as follow: a) To understand the problem: to identify the known and unknown element, and formulate them into a mathematical model and to examine sufficiency element for solving the problem; b) To select solving strategy, to elaborate; c) to execute enumeration or solving mathematical model; d) To interpret solution toward the previous problem, and to examine the truth of solution.

When we closed attention on activities in completing a mathematical problem solving, beside student should master a certain mathematics content, student needs to possess positive mathematical attitudes among other things are: persistent, liking mathematics, having interest in learning mathematics. In other words, student has high desire to solve a difficult mathematics task. Andiwinata (2015), Polking (as cited in Sumarmo, 2010, Hendriana, Rohaeti, Sumarmo, 2016) and Priyanto (2016) call the positive mathematical attitudes as mathematical disposition (MD). Furthermore, Polking details indicator of mathematical disposition as follow: a) Having self efficacy in solving problem, giving a reason, and communicating mathematics ideas; b) Having flexible attitude in investigating mathematics ideas, and attempting to get various strategy in solving problem; c) Having persistent, interested in and curious attitudes; d) To perform habit to monitor and metacognitive thinking; to demonstrate appreciation to the role of mathematics in culture and value and in mathematics as a tool and symbol language. Similar indicators of MD are proposed by Silver (as cited in Sumarmo, 2010, Hendriana, Rohaeti, Sumarmo, 2016) such as: self confidence, self efficacy, curious, fond of doing mathematics tasks, diligent and persistent, flexible, and reflective attitudes.

Some experts suggest some activities for improving mathematical disposition namely: a) Create conducive learning environment, avoid irrelevant student’s activity, help students to manage their time, and promote self confidence for being un-easy panic (Schunk as cited in Hendriana, Rohaeti, Sumarmo, 2016); b) Make student realize on the importance of possessing mathematical disposition attitudes, perform teacher to behave mathematical disposition attitudes, familiarize students to behave mathematical disposition attitudes, and carry out integrated and continuous mathematics teaching-learning process (Sauri, 2010).

Mathematics curriculum (Departemen Pendidikan Nasional, 2013) suggests that mathematics ability such as MPSA and mathematics attitudes namely DM should be improved accordingly and proportionaly. Polya (1985), and Glasersfeld (as cited in Suparno, 1997) propose a worthwhile expression of teacher’s role that is teacher’s task is not only to deliver information but the most important thing is to help students to construct mathematics concepts by their own
ability, and then using assimilation and accommodation processes students composed a new meaningful concept. In order to conform suggestion of mathematics curriculum, Polya’s suggestion, (1985) and Glasersfeld’s advises (as cited in Suparno, 1997), researchers select contextual teaching and learning (CTL) for improving student’s MPSA and MD. Rusman (2012), explains that CTL is a teaching approach which starting by presenting a relevant contextual problem for mastering a concept and then, it is developed for obtaining other higher mathematics abilities. For conducting CTL, Rusman, (2012), proposes seven main phases of CTL such as: constructivism philosophy, to guide students by questioning; to motivate students, to invent; to build learning society; modelling; reflection; and authentic assessment.

In those phases of CTL, student is facilitated for mastering the learned concept and obtaining other higher mathematics ability such as MPSA, and for promoting positive learning habit such as persistent, self confidence, working together, unafraid to face difficult mathematics tasks which constitute of MD attitudes. This argument supports researchers’ selection that CTL will be conformed with our wish.

Such as any teaching approach, there are advantages and disadvantages of CTL. Mahanani (2014) explains some advantages of CTL namely: Teaching learning become more meaningful, and real, b) Teaching learning process become is more productive, CTL is centered on student’s activities cognitively and affectively, class room not only for getting information but as a palce for student to test their invention, a new knowlegde is invented by student and not informed by teacher, a CLT situation is pleasantly. Besides those advantages, Mahanani (2014) proposes some disadvantanges of CTL such as: CTL needs more time, maybe arouse non condusive class situation, teacher needs to give more attention and guides.

Some studies reported superiorities of CTL on improving students’ MPSA (Fitriani, 2017, Juliati, 2016, Permata, 2015, Yonandi, 2010), on students’ MD (Bernard and Rohaeti, 2016, Fitriani, 2017, Ruhiyat and Sugandi, 2017). In those studies students’ MPSA were at medium grade level, while students’ MD were at fairly good level. Even tough, students getting treatment with conventional teaching attained at low grades level on MPSA and at medium grades level on MD. Beside that, some studies (Johanto, 2017, Juliati, 2016, Madio, and Sofyan, 2017, Nurmayanti, 2016, Pujiastuti, 2014, Rosalina, 2016) reported that students getting treatment with various innovative teaching approaches attained at medium-fairly good grade level on MPSA, whereas student taught by conventional teaching at low-medium grade level. Despite some students mostly taught by conventional teaching still realized difficulties on compiling MPSA, those studies pointed out that CTL and other innovative teaching approaches had better role than conventional teaching on enchancing students’ MPSA. Considering of findings on those studies and MPSA and MD as essential mathematics learning outcomes for high school students, teachers should still improve students’ MPSA and MD by carrying out CTL or other innovative teaching approaches.

METHOD

This study is an experiment with pretest postest and controll group design having a goal to analize the role of CTL on improving student’s MPSA (Sample 1 and 2) and MD (Table 1). The subjects of study are 40 tenth grade students from a Madrasah Aliyah (MA) in Bandung. The MA is determined purposively, and the students are from two thenth grade classes which selected randomly from five classes of tenth grade in the MA. Instruments of this study consist of a mathematical problem solving test, and a mathematical disposition scale. The test consists of 4 essays and the scale consists of 26 statements. Using Hendriana and Sumarmo (2016) and Sumarmo (2015) as references, the study obtained charateristics of the MPSA test as follow. The item validity (IV) are ranged between .65 < IV < .90; the reliability test (r) is r = .41,
discriminant power (DP) is $0.27 < DP < 0.44$, and difficulty index (DI) is $0.24 < DI < 0.67$. In the following we attach some samples of the instruments of this study.

**Sample 1. Item test of MPSA**

It is given $\Delta ABC$ with right angle in $B$, $AC = 2\sqrt{5} \text{ cm}$ and $BC = 2\sqrt{3} \text{ cm}$. Point $D$ is in $AC$ line so that $\angle BAD = \angle DBC$. Draw a figure to represent the information, formulate mathematical model for calculating $BD$ and $AD$, and then solve them. Examine the truth of your answer.

**Sample 2. Item test of MPSA**

Two boat $A$ and $B$ having a distance 10 km. The boat $B$ is in direction of $100^\circ$ from boat $A$. Boat $C$ is in direction of $160^\circ$ from $A$. Boat $C$ is in direction of $200^\circ$ form $B$.

a. Draw a sketch of that situation.

b. Determine the distance of $C$ from $A$ and from $B$

c. Examine the truth of your answer accompanied with exaplanation.

(Notes: $\sin 40^\circ = 0.6428$; $\sin 80^\circ = 0.9848$; $\sin 60^\circ = 0.866$)

<table>
<thead>
<tr>
<th>No.</th>
<th>Statements</th>
<th>SA</th>
<th>A</th>
<th>DA</th>
<th>SDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I realized that mathematics plays an important role in fields such as economics and science</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I have trouble converting math problems related to everyday life into mathematical situations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>If I come across a math problem that's difficult, I'll try to solve it first before asking my friends</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I have trouble finding alternative methods of solving math problems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: SA: strongly agree; A: agree; DA: disagree; SDA: strongly disagree

Table 1 shows some of statements for testing mathematical disposition. We give it to the participant to see how mathematical disposition of senior high school students.

**RESULTS AND DISCUSSION**

**Results**

Statistics Description of student’s MPSA, its N(Gain) and students’ MD is attached in Table 1. From Table 2, study found there were no difference grades of student’s MPSA in both classes before the learning process, and the grades were very low ($12.64\%$ and $11.91\%$ out of ideal score). After the learning process, on MPSA, its N(Gain) and on MD, students getting treatment with CTL attained higher grades than the grades of student taught by conventional teaching. On MPSA, both grades were still at a low level ($36.09\%$ and $27.36\%$ out of ideal score), while on MD the both grades were at a low-medium level ($61.23 \%$ and $56.08\%$ out of ideal score) and on N< Gain> of MPSA, the grade still at a low grade level ($0.27$ and $0.18$).
Table 2. Statistics Descriptions of Students’ MPSA and Students’ MD in Both Teaching Approaches

<table>
<thead>
<tr>
<th>Variables</th>
<th>Statistic</th>
<th>CTL (n= 20 Sts)</th>
<th>Conventional Teaching (n = 20 Sts)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td>MPSA IS: 55</td>
<td>$\bar{x}$</td>
<td>6.95</td>
<td>19.85</td>
</tr>
<tr>
<td></td>
<td>$%$</td>
<td>12.64</td>
<td>36.09</td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>7.56</td>
<td>4.82</td>
</tr>
<tr>
<td>MD IS: 106</td>
<td>$\bar{x}$</td>
<td>64.90</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$%$</td>
<td>61.23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>6.58</td>
<td></td>
</tr>
</tbody>
</table>

The testing hypothesis of mean difference of MPSA, its N Gain of MPSA, and of MD were attached on Table 3.

Table 3. Testing Hypothesis of Mean Difference of MPSA, and MD on Both Teaching Approaches

<table>
<thead>
<tr>
<th>Variables</th>
<th>Teaching Approach</th>
<th>MPSA</th>
<th>N-Gain</th>
<th>Sig (2-tailed)</th>
<th>Sig (1-tailed)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPSA</td>
<td>CTL</td>
<td>19.85</td>
<td>4.82</td>
<td>20</td>
<td>0.005</td>
<td>MPSACTL &gt; MPSACT</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>15.05</td>
<td>5.29</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N-Gain</td>
<td>CTL</td>
<td>0.27</td>
<td>--</td>
<td>20</td>
<td>0.000</td>
<td>N-Gain MPSACTL &gt;</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>0.39</td>
<td>--</td>
<td>20</td>
<td>0.000</td>
<td>N-Gain MPSACT</td>
</tr>
<tr>
<td>MD</td>
<td>CTL</td>
<td>64.90</td>
<td>6.58</td>
<td>20</td>
<td>0.024</td>
<td>MDCTL &gt; MDCT</td>
</tr>
<tr>
<td></td>
<td>CT</td>
<td>59.45</td>
<td>12.78</td>
<td>20</td>
<td>0.012</td>
<td></td>
</tr>
</tbody>
</table>

Note: MPSA: Mathematical Problem Solving Ability Ideal score: 55
MD: Mathematical Disposition Ideal score MD: 106

Further analysis is about association between mathematical problem solving ability (MPSA) and mathematical disposition (MD). The association was analyzed by using contingency table such as in Table 4 and using $\chi^2$ testing in Table 4. From Table 3, it was found that there were different numbers of students with similar level on MPSA and MD, such as Medium MPSA (2) and medium MD (16), low MPSA (18) and low MD (1).

Table 4. Contingency Table of MPSA and MD In CTL Class

<table>
<thead>
<tr>
<th>MD</th>
<th>MPSA High</th>
<th>Medium</th>
<th>Low</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
<td>14</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>16</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>
In Table 5, the analysis obtained value $\chi^2 = .556^a$ and sig.(2 tailed- .757 > .05). This meant that there was no association between MPSA and MD.

### Tabel 5. Chi-Square ($X^2$) Test for Mathematical Problem Solving Ability and Disposition

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>0.556$^a$</td>
<td>2</td>
<td>0.757</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>0.947</td>
<td>2</td>
<td>0.623</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>0.111</td>
<td>1</td>
<td>0.739</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Observing the low grade level of students’ MPSA (those were 27.36% and 36.09% out of ideal score), it pointed out that there were many students realized difficulties in solving MPSA tasks. This analysis was supported by mean score of each item task of MPSA such as in Table 6. In almost mean score of item of MPSA less than 50 % out of ideal score of its item test of MPSA. The finding of the very low grade level of students’ MPSA this study was similar to the finding of Krismayanti (2017), however those findings were different with findings of other studies (Fitriani, 2017, Julianti, 2016, Permata, 2015, Yonandi, 2010) that using CTL and some other studies using various teaching approaches (Johanto, 2017, Julianti, 2016, Madio and Sofyan, 2017, Nurmayanti, 2016, Pujiaatuti, 2014, Rosalina, 2016) students obtained at medium-fairly good grade level. It seemed that MPSA task constituted as difficult task for Madrasah Aliyah (MA) but not for senior high school students.

### Table 6. Mean Score of Each Item Test of MPSA Tasks In Both Classessu

<table>
<thead>
<tr>
<th>Item test</th>
<th>IS</th>
<th>Teaching Approach</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CTL</td>
<td>Conventional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$\bar{x}$</td>
<td>% out of IS</td>
<td>$\bar{x}$</td>
<td>% out of IS</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>14</td>
<td>6.05</td>
<td>43.21%</td>
<td>4.30</td>
<td>30.71%</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>6.80</td>
<td>85.00%</td>
<td>4.05</td>
<td>50.62%</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>3.45</td>
<td>20.29%</td>
<td>3.55</td>
<td>20.88%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>3.55</td>
<td>22.19%</td>
<td>3.15</td>
<td>19.69%</td>
<td></td>
</tr>
</tbody>
</table>

### Results

Analysis of student’s activities during CTL and conventional instruction were illustrated in Figure 1, Figure 2, Figure 3, and Figure 4. Despite students obtained at low grade level on MPSA, and at medium grade level on MD, students performed more active compared to students’activities in conventional instruction. This condition might be caused of students not mastered yet prerequisite of mathematics content of this study. Hence, before teacher are going to teach a new mathematics content, teacher should examine students’ mastering the prerequisite of the new mathematics content.

Figure 1 show that how students unafraid to ask teacher when they not understand, figure 2 show that how students still passionate worked in a small group, figure 3 show that students
were discussing their opinion in small working group, and figure 4 show that how students represent their discussion results.

Figure 1. Students was unafraid to ask to teacher when she did not understand teacher’s explanation in CTL instruction

Figure 2. Students were still passionate worked in small group despite teacher observed them

Figure 3. Students were discussing in their small working group

Figure 4. A representative student of a group explained their work in front of the class

CONCLUSION

Based on findings and discussion, the study derives conclusion and suggestion as follow. Contextual teaching and learning (CTL) conferred better role than conventional teaching on improving student’s mathematical problem solving ability (MPSA), its N(Gain), and student’s mathematical disposition (MD). On those learning mathematics outcomes, students getting treatment with contextual teaching and learning obtained better grades than the grades of students taught by conventional teaching. Although, students’ MPSA in both classes were still at low grades level. Like that on MD, first group students attained at medium grade level while the second group students obtained at low grade level. Students in both classes still realized difficulties in solving mathematical problem solving tasks. Other conclusion were that there was no association between MPSA and MD, and students performed active learning during CTL instruction.

In this study, students’ MPSA were still at a low grade level. In order to improve students’ MPSA it is suggested before teacher are going to teach a new mathematics content, teacher should have to examine students’ mastering the prerequisite of mathematics will be learned. Further for obtaining better students’ grade on MD, it was suggested a) Create conducive learning environment, avoid irrelevant student’s activity, help students to manage their time, and promote self confidence for being un-easy panic; b) Make student realize on the importance of posessing MD attitudes, teacher should behave as wish in MD attitudes, familiarize students
to behave as wish in MD attitudes, and carry out integrated and continuous mathematics teaching-learning process.

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