Mathematical creative problem solving ability and self-efficacy: (a survey with eight grade students)

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Abstract. This study is a survey that aims to analyze students’ creative problem solving ability, self-efficacy, and associations. This survey involved 25 eighth grade, a test of mathematical creative problem solving ability (MCPSA), and a mathematical self-efficacy (MSE) scale. The MCPSA essay test contains 3 items and the MSE scale is compiled in Likert’s model. The survey found that students MCPSA were at low grade level and students were aware of the difficulties in some items of MCPSA tasks. Even tough on MSE, the survey found that students were at fairly good level. The other findings, there is no association between MCPSA and MSE.

1. Introduction

In fact, mathematical problem solving ability (MPSA) is one of essential mathematics ability should be possessed by and be improved on junior high school students. Some reasons which supporting that statement among other things is MPSA is attached in the goal of mathematics teaching [1,2]. Besides that, the importance of possessing MPSA by students is in line with Branca’s conception [3] namely: Mathematical problem solving constitutes main process in the goal of teaching-learning mathematics, moreover it is basic ability and the hart of mathematics.

Besides MPSA, mathematical creative thinking ability (MCTA) is an essential mathematics learning outcome should be improved on student high school as well. The reason of that statement not only it is attached in the goal of mathematics and the vision of teaching mathematics but also it relates with daily life. Some reasons among other things are: a) Mathematics teaching having a goal: to improve student’s potency to become a critical, creative, logical, accurate, and innovative human [2], Vision of mathematics teaching; b) In fact, creative thinking is a part of life-skill which it is needed for facing fast improvement of science, technology, and to overcome challenges and tight competition; c) Individual who offered opportunity to think creatively will grow well and able to overcome challenges. Conversely, when an individual does not allow to think creatively he will be easy frustration and unsatisfied. When both mathematical abilities were combined it become mathematical creative problem solving ability (MCPSA) that is an essential and important ability to be improved on high school students.

Polya proposes problem solving is an effort to seek way out from a case which not easy to solve [4]. When there are various possible solution of the case and we need to select alternative effective solution, this situation related to a concept named creative problem solving (CPS). Creative Problem Solving (CPS) is a structured for solving problems or finding opportunities, used when you want to go beyond
conventional thinking and arrive at creative (novel and useful) solutions. A primary difference between CPS and other problem-solving processes is the use of both divergent and convergent thinking at each step, and not just when generating ideas.

Polya proposes that CPSA is not just about having ability of solving a problem but it involves creative activities in each step of problem solving process [4]. Those activities are: a) Fact finding; b) Problem finding; c) Idea finding; d) Solution finding; e) Acceptance finding. Those activities, are preceded with divergent thinking and are ended with convergent thinking. Isaksen and Treffinger describe divergent thinking is ability to construct or to obtain various possible response, ideas, options, or alternatives for a problem or obstacles [5]. Divergent thinking constitutes among other some processes such as: a) Process for thinking various possible and rational ideas; b) Interpretation process and evaluation on the ideas; c) Seeking unusual possibilities in constructing unique ideas. To complete those processes, then Mitchell and Kowalik [6] offer some effective steps of convergent thinking namely: a) Postpone conclusion; b) Consider some ideas; c) Accept all ideas; d) Increase self-ideas on those collected ideas; e) Verify those ideas step by step; f) Compile a combination idea. Other writers, Mitchell and Kowalik [6] also propose that CPS process is a process, method, or system for approaching a problem in an imaginative way and resulting in effective action. Then they specify the steps of CPS processes as follow Mitchell and Kowalik [6]: a) Mess finding; b) Data finding; c) Problem finding; d) Idea finding; e) Solution finding; and f) Acceptance finding.

Based on those aforementioned arguments, it can be enclosed that CPS process is classified as high order thinking (HOT). When CPS is applied in mathematics context it is called mathematical creative problem solving (MCPS) task, so MCPS task is classified as high order mathematical thinking (HOTMT) as well. We know that when a student is going to solve a HOTMT task such as MCPS task, he or she should have strong desire and motivation for solving it, and he or she has confidence will succeed in solving MCPSA and other mathematics task as well. Those positive behaviors illustrate part trait of self-efficacy. Self-efficacy is a type of behavior accompanied discipline and great effort. Some writers define self-efficacy term as follow: a) Self efficacy is personal believe toward his or her ability on managing and carrying out a series activities for obtaining certain out comes [7]; b) Self efficacy is personal believe on something able to do (Schunk as cited in [7]); c) Self efficacy is personal believe that something is good or bad, precise or false, able or unable to be done as required demand; d) Self efficacy is personal assessment that he able to do the wish action when facing something happened. Then, Bandura [7] offers some indicators of self-efficacy such as: a) Able to overcome difficult problems; b) Believe is his or her own success; c) Unafraid to meet a challenge; d) Unafraid to take risk on his or her own decision; e) Realize on his or her own advantages and disadvantages; f) Able to interact with other people; g) Persistent and uneasy give up.

Bandura found that junior high school students getting treatment with Challenge Based Learning obtained at fairly good grade level on CPS, while students taught with scientific approach attained at low-medium grade level [7]. While, some studies Atun and Tiurlina found that MCPS ability in Elementary School fact finding is the highest aspect of the student’s mathematical ability and the lowest aspect is acceptance finding [8,9]. Al Mutairi found that study showed sub scores of the creative thinking in the favour of the experimental group indicating the effectiveness of using brain storming strategy in developing creative thinking skills [10]. Those aforementioned arguments, motivate researchers to carry out a survey with junior high school students on MCPSA and MSE that having goal as follow.
• To analyze the type of students’ difficulties in completing the MCPSA assignment.
• To analyze association between MCPSA and MSE

2. Experimental method
This study is a survey which having a goal to analyze students’ MCPSA and MSE, its association, and student’s difficulties on solving MCPSA tasks. The study involved 25 eighth grade students, a MCPSA test, a MSE scale. The MCPSA test consisted of 3 item and followed by some questions. Reliability test was $r = .78$; item validity were $.69 \leq IV \leq .82$; discriminat power were $.27 \leq DP \leq .52$, and difficulty index were $.28 \leq DI \leq .67$. Self efficacy scale contained 30 items, reliability of Self Efficacy Scale was $.82$, and item validity were $.37 \leq IV \leq .72$. In the following, we attached sample items of MCPSA test, sample of MSE scale.

2.1. Sample 1. Item of MCPSA test
Dika has a car toy that moved by a battery. The car toy is located 6 cm from the edge of a room, and it moves at constant velocity 15 cm per second.
• Formulate the distance between car toy form the side of the room after t second, when distance between the car toy and side of the room is s.
• Complete which this t is time in second, s is distance car position and side of room

| Table 1. Distance car position at t time. |
| T | 15t | 6 + 15t | S | (t,s) |
|---|---|---|---|---|
| 0 | .......... | .......... | .......... | .......... |
| 1 | .......... | .......... | .......... | .......... |
| 2 | .......... | .......... | .......... | .......... |
| 3 | .......... | .......... | .......... | .......... |
| 4 | .......... | .......... | .......... | .......... |

• Draw the situation in a graph in cartesius coordinat TOS (Axis s in distance in cm, axis t is time in second);
• Draw each point (t,s) in that cartesius coordinat TOS;
• Attract a line through each point vertical to s axis;
• Determine distance between car toy and side of room after 4 seconds.
• Determine how long of time, when the car toy is at 92 cm from the side of the room.

2.2. Sample 2. Item of statements of mathematical self-efficacy scale

| Table 2. Item of statements of mathematical self-efficacy scale. |
|---|---|---|---|---|
| Number | Statement | SA | A | DA | SDA |
| 1 | I am able to solve well difficult mathematics problem of line equation | | | | |
| 2 | Mathematics problem given by teacher is very challenged to solve. | | | | |
| 3 | I am ashamed to ask teacher to explain a difficult mathematics problem | | | | |
| 4 | I am nervouse to solve a mathematics problem in front of the class | | | | |
| 5 | Percieve non rutime and odd mathematics task as a good excercise for improving mathematics ability. | | | | |
| 6 | I try to seek alternative solution when I fail to solve a difficult mathematics problem | | | | |

Note: SA: strongly agree, DA: disagree, A: agree, SDA: strongly disagree
3. Result and discussion

Description of students’ MCPSA and MSE were attached in Table 3. From Table 3, the survey found that on MCPSA entirely, students’ grade was 11.68 (41.7% out of ideal score). It meant that students grade of MCPSA was classified as low-medium level. This is in line with [4] that proposes problem solving is an effort to seek way out from a case which not easy to solve. Some previous studies, reported that on mathematical problem solving ability (MPSA) and on mathematical creative thinking ability (MCTA) students getting treatment with innovative teaching obtained at medium grade level, and students taught by conventional teaching attained low-medium grade level. When we compared those findings, it could be concluded that on MCPSA, finding of this survey was similar to findings on MPSA and MCTA of students taught by conventional teaching. It was rational caused of in this survey, students not yet getting treatment with any innovative teaching approach or this finding was a result of conventional teaching by teacher before this survey.

When we observed in detailed namely on parts of each number, students revealed difficulties in some question of each number (the plan and conduct an experiment by giving a certain innovative mathematics teaching approach so that it can improve students’ MCPSA and MSE accordingly. However, in this survey there was different quality of students’ MSE and quality of students’ MCPSA.

The survey found on MSE, $X = 82.26$ (68.7% out of ideal score). From table 3, this finding was similar to the findings of some previous studies that students’ MSE were classified at medium-fairly good grade level.

Further analysis, is concerning association between MCPSA and MSE. The analysis obtain value $\chi^2 = 7.132$ and sig.(2 tailed-.103>.005). This is meant that there is no association between MCPSA and MSE. From Table 4, it is found that no students with high score of MCPSA. Even almost students

| Variable | Number | 1 | 2 |
|----------|--------|---|---|
| Indicator | A | b | c | d | e | f | Sum |
| MCPSA    | 1.04 | 0.72 | 0.86 | 0.64 | 0.48 | 0.44 | 4 | 1.48 | 1.04 | 0.96 | 3.48 |
| %        | 52%  | 36%  | 34%  | 32%  | 24%  | 22%  | 33.30% | 74%  | 52%  | 48%  | 58%  |
| s        | 0.84 | 0.68 | 0.90 | 0.76 | 0.51 | 0.58 | 2.04 | 0.71 | 0.79 | 0.93 | 1.42 |

| Variable | Number | 1,2,3 |
|----------|--------|-------|
| Indicator | a | b | c | d | E | Sum |
| MCPSA    | 1.12 | 0.88 | 0.84 | 0.76 | 0.6 | 4.2 | 11.68 |
| %        | 56%  | 44%  | 42%  | 38%  | 30%  | 42%  | 41.70% |
| s        | 0.78 | 0.65 | 0.80 | 0.72 | 0.50 | 1.98 | 4.86 |

| MCPSA | MSE |
|-------|-----|
| High  | High | Medium | Low | Sum |
| High  | 0    | 0     | 0   | 0   |
| Medium| 2    | 1     | 1   | 4   |
| Low   | 8    | 4     | 9   | 21  |
| Sum   | 10   | 5     | 10  | 25  |

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attain low grade on MCPSA (8), and most of them with at low grade on mathematical self efficacy (9). This findings support prior statement that MCPSA is difficult task for junior high school students.

4. Conclusion
Based on findings and discussion, the survey derived conclusion as follow. Students’ mathematical creative problem solving ability (MCPSA), was at low-medium grade level, and students’ MSE was at fairly good grade level. Students realized many difficulties on solving MCPSA task. Besides that, students on both teaching approaches realized difficulties in solving MCPSA problems. The other conclusion was that there was no association between MCPSA and MSE. Based on the conclusion and discussion the survey proposed some suggestion as follow. The students’ grade on MCPSA was at low grade level. For obtaining better meaningful CPSA, it was suggested: a. to examine students’ abilities of its prerequisite firstly; b. students should be motivated to select and to solve more exercises by their self on MCPSA; c. students asked to write the formulas and rules which used on each step in solving the problems as well.

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