DESCRIBING TAXONOMY OF REFLECTIVE THINKING FOR FIELD DEPENDENT-PROSPECTIVE MATHEMATICS TEACHER IN SOLVING MATHEMATICS PROBLEM

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Abstract—Reflective thinking is one of the important things which become a concern in learning mathematics. Reflective thinking is also used to look for solution toward the problem of mathematics given in the classroom because it can increase student’s willing in completing it. Reflective thinking is identified as a skill for future competence so that it should be trained to students in facing the challenges and responding demands of the 21st century. One of reflective thinking models is taxonomy of reflective thinking which aims to see someone with a reflective thinking skill by checking up, evaluating and testing the truth of a mathematical task which has been done. The main objective of this paper is to describe the ability of prospective teachers’ mathematical problem solving based on taxonomy of reflective thinking. To achieve this purpose is used a qualitative research in describing in depth related to mathematical problem-solving of subject who can be investigated from the subject’s behavior in completing the tasks assigned by paying attention the aspect of taxonomy of reflective thinking. Subject, in this research paper, is student teacher who has cognitive style of field-dependent. This research report describes that the subject used some mathematics concepts and determined a strategy in solving mathematics problem by using the main point of problem based on keywords in two ways which can be implemented in every day life.

Index Terms—Taxonomy of Reflective Thinking, Field-Dependent, Prospective Mathematics Teacher, Problem Solving.

1 INTRODUCTION

The skill of mathematics problem solving is one of the competencies or skill which should be owned by a student in mathematical learning [1]. In solving a problem of mathematics, it is required a higher order thinking skills which it can promote students’ curiosity in order to there is a wish by students in solving the mathematics problems encountered. One way in solving mathematics problem is applied thinking skills namely reflective thinking [2] because it is one of the types of high order thinking which can bring up the curiosity of students [3]. This is in the same purpose of the curriculum in 2013 in Indonesia stated that one of the main and basic competencies as science behavioral what students should have is curiosity. Moreover there are many skills required by students in entering the 21st century, namely skill of cognitive, intrapersonal and interpersonal. It indicates that the ability of reflective thinking is a competence in the future that should be known and trained to students to prepare in adapting changes and responding requirements of the 21st century. Therefore, to support this goals, the educational personnel and institutions (LPTK) makes serious efforts to create a prospective teacher who has responsibility and the ability to reflective thinking [4]; [5].

King and Kitchener [6] stated that, by using the skill of reflective thinking, student can look for the solution or break down more complicated situations because student’s capability in using more mathematics concepts will be directed between one concept to another concepts needed and the solution which had been obtained tend to be finished correctly and appropriately. It is caused by the using of skill of reflective thinking could give chances for students to investigate their solution about their error or misconceptions in solving mathematics problem. This is in line with the results of Ambrose’s [7], Geieter’s [8] and Koszalka’s [9] research stated that reflective thinking gave a chance or time for students in justifying the error of solution related to misconceptions done by thinking about what students did and why students did it. It explains that the reflective thinking will occurs after someone or students finishing or solving mathematics problem. Students can do it by checking the mistake based on the concepts that are used and justifying these misconceptions. As a consequence, students can try to improve their skills in using mathematics concepts [10].

Pappas [11] developed a reflective thinking model that is named taxonomy of reflective thinking. It aims to investigate the students’ ability in using their reflective thinking skills by checking up, verifying or evaluating the correctness toward both of a task or problem solving done and a learning process implemented in the classroom. Taxonomy of reflective thinking, according to Pappas [12], is a task classification when either problem solving or learning has been done in the classroom. Taxonomy of reflective thinking is classified in six levels which is aligned with the six taxonomy of Bloom. These levels are characteristics to analyze data obtained related to the taxonomy of reflective thinking in completing mathematics problems; (1) remembering, (2) understanding (3) applying, (4) analyzing, (5) evaluating and (6) creating. Thus, taxonomy of reflective thinking can be identified after mathematical problem solving or the learning process is done.

In teaching and learning process, all activities are designed to accompany students for obtaining knowledge, skills and proficiency. However, educators often facilitate all students’ activities by the same method or procedure. We know together that students have different characteristics so that students will learn to master, know, prepare information, looking for solution toward mathematics problems, or to lecture the subject.
matter well, especially for subject of mathematics, they will explain or carry out in also different ways [13]. One of the different characteristics of students is the difference in cognitive style. The difference in students’ cognitive styles has an impact on students’ ability to think reflectively and solve mathematics problems [11]. Students can complete or solve more complex tasks by using reflective thinking because students’ thought will be adapted toward problem and students can use their ability or skill to think reflectively toward solution of the problem. By using it, students’ solution gotten will tend to be true and correct. This is in line with the results of the study of King and Kitchener [9] which stated that by using reflective thinking, somebody will be help in solving complicated situation because it helps somebody identify the concepts of mathematics used to solve more complex situation. Furthermore, the skill of reflective thinking also engages the activities of cognitive namely analyzing, comparing, synthesize, clarify, and choosing what somebody choses the way in solving it. These activities also show the reflection itself [14, 15]. When somebody does these activities, then there is a tendency for students to think differently. It is caused by their character or their cognitive styles. These differences have an impact on students’ thinking abilities especially in reflective thinking and solving the problems. This is consistent with the results of research of Coop and Sigel which stated that the style of cognitive owned by someone correlates with their intellectual and perceptual behavior [16]. Intellectual is related to one’s thinking ability, while perception is related to one’s ability in viewing and interpreting anything. There are many literatures which had identified about cognitive styles. In 1965, Kagan [17] introduced two cognitive styles namely impulsive and reflective. Kagan categorized the style of cognitive which is embraced by someone based on the amount of time used by a person in solving the problem or situation and the accuracy of a person’s answers to the problems presented. A person who uses short time in solving the situation but he is less careful so that the answers obtained tend to be much wrong. The person tends to have an impulsive cognitive style. Meanwhile, a person who uses long time in responding the situation, but he is carefully in answering the problem so that the answers obtained tend to be true, it is called person who has reflective cognitive style. On the other side, Tenant [18] and Witkin, et.al [19] had developed a cognitive style based on continuous global analytics. Based on this idea, the styles of cognitive are categorized into two types, namely cognitive style of field-dependent and field-independent. Somebodies of field-independent are analytic, they can use their styles in choosing the way in responding the situation, so that their idea or their perception only a small percentage is affected when a situation changes. Somebodies prefer to sort out the parts of patterns and analyze these patterns based on components. On the other hand, somebodies of field-dependent tend to be difficult in differentiating responses through the situations that faced so that if they are in the new situation, their perceptions are easy to be changed. It is caused by the manipulation of situations from their surroundings. Furthermore, somebodies of field-dependent tend to perceive a pattern as a whole. They do not separate it into parts. Based on above, it can be explained that difference on students’ cognitive styles, it allows students to solve problems in many ways. It depends on their skill in thinking reflectively and their perceptions toward a given situation. To find out if it really happens, it needs to be explored further. To investigate about field-dependent prospective mathematics teacher’s reflective thinking in solving mathematics problem, it will need to be further tracked.

2 METHOD

The purpose of this research paper is to describe the ability of prospective teachers’ mathematics problem solving based on reflective thinking taxonomy. This research paper chose a qualitative approach. The research was carried on prospective mathematics teacher in 5th semester at Universitas Muhammadiyah Makassar. Subject of research is selected who has cognitive style of field dependent and has good communication ability so that the description of subject’s reflective thinking skill can be explained well.

In determining the subject of research who has field-dependent cognitive style, it was used test of group embedded figure (GEFT). This test consists of 25 question items. It is divided into three sessions. The first 7 session items as exercises, the second and the third session consists of 9 items. The second and the third session serve as the assessed session. The criteria used in selecting research subject is if the subject can answer correctly 0 - 9. To achieve the research purpose stated earlier, then the researcher used a non-routine task to be completed by subject of research. After completing it, the subject of research was interviewed to explore the ability of subject in solving mathematics problem based on the aspects of taxonomy of reflective thinking. Further, the researcher analyzes the data by adopting exploration approach [20]. The data was analyzed by categorizing, reducing and interpreting to make a conclusion in describing prospective teacher’s taxonomy of reflective thinking in mathematics problem solving.

3 RESULTS

The aims of this paper was to describe field-dependent prospective mathematics teacher in solving mathematics problem based on taxonomy of reflective thinking. Previously, researcher explained that a qualitative approach is used to describe mathematics problem solving of prospective mathematics teacher based on taxonomy of reflective thinking. In this section, it will be described how researcher used a methodology toward the results of interviews and data documents based on the results of subject research in solving mathematics problem. Researcher will explore all the findings obtained and then it will be described in detail. The activities of subject’s reflective thinking described based on reflective thinking taxonomy which is divided in six level. They are: (1) remembering, (2) understanding (3) applying, (4) analyzing, (5) evaluating and (6) creating. The results of interview from the subject of research on collecting data that describes the subject’s ability in mathematics problem solving based on taxonomy of reflective thinking displayed as follow.

The first level, remembering, the participant restates all information contained on the mathematical problem by using other words and explain it non-sequentially. Subject of research paper sometimes explained from the main point of the problem to other poin of the problem. Participant can mention the main points of the problems presented to her. Participant always made an underline to show and choose her the most correct final answer. In addition, to ensure or assure that participant
got the correct answer, the participant wrote off her answer which was less precise and replaced it with other right answer. In detail, it is described the result of interview from the subject of research as follow.

R: “Please tell me, are you still remember about your solution or settlement toward this mathematical problems which you have done?”

S: “I remembered that this problem asked me to help Mr. Syukri (Taufan’s father) in looking the best way to avoid a loss by determining a number of mangoes to bring them in Mr. Syukri’s shop. Mr. Syukri is a trader. Distance between Mr. Syukri’s house to Syukri’s shop is 20 km. … Taufan must bring the mangoes to his shop by using basket which contains no more 20 mangoes and there are 60 mangoes which must bring in the shop. Taufan has a habit to eat one mango every 1 km. The main problem is how the strategy used to help Mr. Syukri in bringing the highest number of mangoes to get in his father’s shop. When I solve this problem, I always made underline my answer which I think it’s true, and sometimes I cross out the answers because it is not true and I replace it.

From above, it can be explained that, in level of remembering, the subject recognizes problems by mentioning the information known by using her opinion and explains it non-sequentially by seeing the text. The participant made underline to give a sign on the most correct answer. The participant crossed over her solution which was wrong and replaced it by the right solution.

The second level, understanding, the subject explained that mathematical problem presented demands to find a strategy to solve problem. The participant also looked for the main point of the problem in settling problem. The participant used four operations in arithmetic. For example: addition, subtraction, multiplication, and division. For the participant, this way is the easy way in finding the solution. In detail, it is explained by the result of debriefing with the subject as follow.

R: “Tell me, how to analyze about your completion or your problem solving?”

S: “I don’t understand Sir. However, I just can explain that I evaluated my answer related to its correct or not”

Based on the excerpts before, it is stated that, in level applying, the subject of research identified that the situation of problem can be implemented in everyday life. Furthermore, the subject of research explained that the concept of mathematical problem can be implemented in economy field. Specifically, the participant gives an example for economic field by illustrating that a company must have a strategy to obtain much profit with few production cost.

The fourth level, analyzing, the participant can not explain well about her mathematical problem solving, the participant can not looked for correlation between many answers which the participant had been gotten.

In more detail, it is illustrated on the result of debriefing with the subject follow.

R: “When you had completed it, according to you this task can be implemented anywhere?”

S: “For me, this mathematics task can be implemented in everyday life for instance in economics exactly in bread company. To make a bread, we should be provided ingredients like flavour, sugar, and plastic as wrapping of bread. This company must recognize that the company must get a lot of profit with little costs of production, so the bread company is not loss.”

Based on the excerpts before, it is expressed that, in level creating, the subject of research can not explain about her mathematical problem solving, the participant can not find the new idea or invention which can be used to create new idea in improving skill as teacher candidate. It can be concluded that, in level creating, the participant can not find the new idea or invention after solving mathematical problem, the participant has not an idea which can describe as a preparation to become a real teacher in society.

4 CONCLUSION

In this study, it is noted that just three levels of taxonomy of reflective thinking which is reached by the subject. The first level is remembering. There are three main points in this level namely (1) the ability to restate all of information by using her own words and gives explanation non-sequentially; (2) marking by using a underline to choose or sign her the most correct answer; (3) making crosses out to the answer which is less precise and replace it with the best answer. The second level is understanding. There are two main points in this level specifically (1) finding a strategy to solve mathematical problem by looking for the key word from the problem; (2) using algebra arithmetic operation as the best way to solve the mathematical problem. The third level is applying. In this level, the researcher has coded data which can give insight to apply the mathematical problem in dayli life for one fields. In...
economic that a company must have a strategy to obtain much profit with little production cost. For level analyzing, evaluating and level of creating cannot be reached by the subject. In conclusion, this research paper gives insight mathematical problem-solving abilities of field-dependent prospective mathematics teacher only reach in the third level based on six taxonomic levels of reflective thinking namely remembering, understanding and applying. It also describes the prospective mathematics teachers' ability characteristics to apply not only knowledge of mathematics but also their awareness to prepare in facing the challenges in the future exactly 21st century to become a professional teacher.

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