A Study Of Reflective-Preservice Mathematics Teacher’s Reflective Thinking In Solving Geometrical Problem

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Abstract—Reflective thinking is one of the basic competencies which must be had by students in learning mathematics, especially in solving mathematical problem. The purpose of this study is to describe how reflective thinking is used in solving geometric problem. The subject of this study is a student who has reflective cognitive style enrolled in Mathematics Education, Faculty of Teacher Training and Education (FKIP), Universitas Muhammadiyah Makassar, Indonesia. This study is a descriptive explorative study with data analysis using qualitative approach. Qualitative approach is chosen to describe in depth related to reflective thinking of prospective teacher in solving geometrical problem that can be seen from the subject’s behavior in completing a given task and semi-structured interviews are administrated to the subject. During the interview, participant is asked by researcher to describe subject’s reflective thinking. There are four main categories to analyze the data related to prospective teacher’s reflective thinking in solving geometrical problem: (1) formulation and synthesis of experience, (2) orderliness of experience, (3) evaluating the experience and (4) testing the selected solution based on the experience.

Keywords: cognitive style, geometrical problem, reflective thinking

I. INTRODUCTION

Every student must have essential competencies in learning mathematics. One of the essential competencies is students’ ability in solving a problem which is suffered or faced. This competence must be recommended to be drilled and appeared since children learn mathematics from elementary school [1], [2]. As a consequence, the handling of mathematical learning process should be done well [3].

In solving a problem, everyone must always involve thinking process, in similar things that were expressed by Solso [4] that thinking activity is directed to produce problem-solving. Additionally, Siswono [5] stated that thinking is a mental activity which is experienced by someone or a person when they were faced with a problem or situation to be solved or resolved. So it can be concluded that the purpose of thinking is to solve a problem or get answers during students complete math problems, students undertake a process of thinking, so that students can find the answers even if the answer is not necessarily true.

One types of thinking that can be applied in teaching mathematics is reflective thinking [6]. This is due to the learning objectives of mathematics such as comprehension, problem solving, connections of mathematical, mathematical communication and other abilities will be owned by the students well when students are aware of what is right, summed up what it is supposed to do when experiencing failure, and evaluate what has been done.
Some institutions and professional development of teachers have been doing the alternate learning to improve reflective thinking skills that are beneficial to student teachers. Such benefits can be felt during becoming student and after the student completes his education in LPTK (Institutions of Teachers and Education Personnel) [7]. Currently reflective thinking is very interesting to study. This is according to Lim’s [8] and Amidu’s [9] research which stated that the reflective thinking had become the most prominent issues in the literature, in particular on professional education of teachers.

Reflective thinking done by teacher aims to achieve learning targets and generate new learning approaches that have a direct impact on the learning process. Furthermore, it is explained that the process of reflective thinking can be used by teachers, student teachers and students in the learning process and learning are included in mathematical problem solving [10]. Therefore, it is suggested that teachers need to engage in reflective thinking and not only learn new ideas related to the concept of learning but also involved in the process of solving problems associated with the mastery of concepts or content of the material that is taught so as to improve the quality of professionalism [11].

A teacher who engages in reflective thinking will be critical to the process of resolving the problem which he did. This is in accordance with Kember’s opinion [12] which stated that the reflective thinking involves assumptions that are critical to the content or process of solving the problem. In addition, teachers who can reflective thinking can master the concept well. Where the opinion is supported by Barrow stating that reflective thinking in solving problem help someone form concepts and abstractions and develop new concepts that eventually produce a solution of the given problem [13].

Therefore, the professional teacher is a teacher who is able to think reflectively and master the concepts so well that it can explain the material well. A similar sentiment was expressed by Yeo [14] and Thames [15] that a teacher cannot be expected to explain the mathematical concept if it does not have a complete understanding of the mathematical concepts being taught. In other words, teachers’ mastery of learning materials (subject matter) becomes very important for success in teaching.

According to Lee [16], there are five phases of reflective thinking, namely:

a) Problem context (identifying the problem)
b) Problem definition (restrict or define the problem)
c) Seeking possible solution (look for possible solutions)
d) Experimentation (using one possible solution of the problem or solution is best done)
e) Evaluation (evaluate / test)
f) Acceptance / rejection (accept or reject)

In addition, Rodgers [11] explained that there are four stages in reflective thinking process, namely:

a) Presence to experience (try to present the experience)
b) Description of experience (describing the experience)
c) Analysis of experience (analyzing the experience)
d) Intelligent action/experimentation (try to practice one of the best solutions in solving problems)

Dewey [17] suggests that there are six phases in reflective thinking:

a) An experience (try to remember things related to the experience before)
b) Spontaneous interpretation of the experience (interpreting spontaneity toward the experience)
c) Naming the problem or question that arise out of the experience (mention any problems or questions that arise from experience)
d) Generating possible explanations for the problem or question posed (building or constructing possible explanations of problems or questions that are given)
e) Ramifying the explanation into full-blown hypotheses (provide explanations in the form of a clear hypothesis)
f) Experimenting or testing the selected hypotheses (practicing or testing the hypothesis chosen)

Based on several previous opinions, the component of reflective thinking process can be illustrated in Table 1 below:
According to the table, obtained construction reflective thinking process with four stages. These stages are: (1) Formulation and synthesis of the experience; (2) Orderliness of experience; (3) Evaluation of experience; and (4) Testing the selected solution based on the experience. To find out what happens when these stages, the student or the subject will be interviewed in-depth on matters concerning the four stages and linkages that may affect it.

By reflective thinking, students can solve more complex problems because the thought of students will be directed and students think reflectively toward solution or settlement of the problem being solved tend to be true and correct. This is according to research King and Kitchener [18] which states that the reflective thinking help somebody in solving complex problems, due to reflective thinking helps a person identify concepts, facts, formulas, and theories that are relevant to the solution of problems identified. In addition, reflective thinking also involves the process of analyzing, comparing, synthesize, clarifying, and choosing what someone is doing that shows the reflection itself [19], [20].

When someone does the activity of analyzing, comparing, synthesize, clarifying, and choosing, then he or she will do it in different ways based on their character. Everyone has a character different or unique [21], so as to learn, master process information, solve problems, and to teach the material well, in this case the mathematics, someone will do it in a way that is different also [22].

Every students has a cognitive style. Differences in cognitive styles have affected the ability of students in reflective thinking and solving problems. This is in accordance with the opinion of Coop and Sigel that the cognitive styles correlate with intellectual and perceptual behavior. Intellectual associated with a person's ability to think, while perceptually associated with a person's ability to view or interpret anything.

A number of cognitive styles have been identified in the literature, for example, Abdurrahman [23] states that one of the dimensions of cognitive style that is enough to attract attention in assessing children who have difficulty in learning is a cognitive style impulsive-reflective (to answer the problem quickly, but a lot of mistakes and addressing slow but less error prone).

Jerome Kagan introduced impulsive and reflective cognitive styles in 1965. Kagan classified the cognitive styles based on the amount of time which is used by a person in responding to a situation and the accuracy of the answers of the response given. People who have the characteristic uses short time in addressing the problem, but no less careful so that the answers tend to be wrong, called the person who had an impulsive cognitive style. Meanwhile, people who have the characteristic uses long time in answering the question, but carefully/meticulously so that the answers given tends to be true, called people who have cognitive style reflective.

With the cognitive styles are different, there is the possibility of students solve problems in different ways, according to the reflective thinking skills and his perceptions of a given problem. To find out if it really happens, it needs to be explored further.

### TABLE I. CONSTRUCTION OF REFLECTIVE THINKING PROCESS

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<td>Problem definition/ Reframing</td>
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<td>Monitoring of the solution process</td>
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<td>Experimenting or testing the selected hypotheses</td>
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<td>Intelligent action/ Experimentation</td>
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II. METHOD

This type of research is a descriptive study with qualitative approach which aims to describe in depth about the student’s reflective thinking process in solving geometrical problem based on cognitive style. To get description of student’s reflective thinking process who has reflective cognitive style in solving geometrical problem, subject was given a task of solving geometrical problems which are presented. Furthermore, subject was interviewed to dig deeper into how students think and acquire new information that may be obtained from the task which is performed by subjects. Data from duties and the interviews were analyzed and further described in the form of written words or a description of the subjects.

The research was conducted in Department of Mathematics Education, Faculty of Teacher Training and Education (FKIP), Makassar Muhammadiyah University. Subjects in this study were student teachers in academic year 2013/2014 (fifth semester). Determination of research class is based on the consideration that students in semester VI have enough time, so that making it easier to do the interview.

The purpose of this study was to analyze the ability of preservice teachers’ reflective thinking process in solving geometrical problem who has reflective cognitive styles. To achieve this goal, several stages will be carried out as follows: (a) the first stage, the determination of research subject who has cognitive style of reflective by using specific criteria; (b) the second phase, preparing problem solving tasks which can describe or appear reflective thinking process of subject that has been validated by several experts; (c) The third stage, interview which is not structured, informal to verify the data from tasks of problem solving; (d) The fourth stage, recording with the recorder and use the records. This meant that no information is missed or lost during the interview; (e) the fifth stage, analyzing of research data related to the process reflective thinking in solving geometrical problems by subjects (preservice teachers).

This research is exploratory descriptive study with data analysis by qualitative approach which main data in the form of words that are linked into sentences. Qualitative method is chosen for profile students’ understanding of the natural background and the main instrument is the researcher's own research. It means that the data which is analyzed in form descriptive and not in the form of figures as well as in quantitative research.

To obtain valid data in this study, then do the validation data. One of the qualitative research validation procedures that can be performed is by means of triangulation. Validation of the data in this way is done by repeatedly checking with different time. Sugiyono [24] called the data validation process by triangulation of time.

III. RESULT

Based on the result of construction reflective thinking process which is divided into four stages. These stages are: (1) Formulation and synthesis of the experience; (2) Orderliness of experience; (3) Evaluation of experience; and (4) Testing the selected solution based on the experience. To find out what happens on every stage related to reflective thinking in solving geometrical problem, the participant or the research subject will be interviewed in-depth on matters concerning the four stages and linkages that may affect it.

The results of task-based interview of the subject on data collection that illustrates the process of reflective thinking in solving geometrical problems by preservice teacher who has reflective cognitive style as follow.

The first stage, formulation and synthesis of the experience, the participant described problem by using his own word, the participant explained problem clearly related to the main point from the problem. The participant also can find the concepts which are related to the problem given. For more clearly, the following is a transcript of the interview excerpt based on this stage.

P Baik. Kira-kira, jika dengan menggunakan bahasa ade sendiri, apa yang adik pahami tentang soal ini secara keseluruhan?
S Terkait pemahaman saya terhadap soal ini yang saya pahami adalah, yaitu soal ini memuntut kita untuk mencari sebuah luas.
P Luas apa?
S Luas dari taman bunga, yang berbentuk persegi atau persegi panjang tapi belum diketahui panjang sisi-sisinya, entah itu apakah panjangnya atau lebarnya, tergantung nanti proses penyelesaian soal saya seperti apa.
P Terus?
S Pada soal ini juga, memuat beberapa konsep persegi atau persegi panjang, konsep luas, perkalian, konsep perbandingan, kensep sudut, dan konsep kesejajaran.
From the transcript above, it can be explained that the participant described the problem by using another word however participant’s explanation still has the same idea from the problem. Furthermore, when the subject identified concept or subject matter which is related to the problem, the participant mentioned not only the concept that ever the participant used in solving a problem before, but also the participant explained that the concept which will be used in solving the geometrical problem. For more clearly, the following is a transcript of the interview excerpt based on this stage.

P Sebelumnya, apakah adik pernah melihat soal seperti ini?
S Nda persis sih soalnya seperti ini, tapi dalam kehidupan sehari-hari atau di sekolah, biasanya, inikan berbentuk soal cerita.
P Kalau soal cerita seperti ini, biasanya itu, memuat konsep aljabar.
S Dalam kehidupan sehari-hari, biasanya kalau soal cerita pada kehidupan sehari-hari itu, biasanya memuat pemisalan seperti seseorang membuka buku, buktunya itu diganti dengan x berapa buah. Kalau misalnya kita membeli 3 buku, kita bisa menuliskan 3x.
P Ok kalo begitu, dulu ketika menghadapi soal yang seperti ini konsepnya terkait apa saja?
S Kalau soal yang dulu, biasanya langsung terkait konsep aljabar, konsep sudut, konsep segitiga, persegi, persegi panjang.
P Masih ada lagi konsep yang lain terkait soal yang pernah ade hadapi?
S Hmm, ok konsep lingkaran pak. Yah mencari luas lingkaran, keliling lingkaran. Ya itu pak.
P Coba, pertikan soal tersebut dengan seksama yang ada dihadapan ade itu. Soal tersebut terkait dengan konsep apa saja?
S Hmm, pertama pasti terkait dengan konsep persegi panjang. Karena dalam soal sudah disebutkan bahwa taman bermainnya berbentuk persegi panjang. Yang kedua, juga ada konsep sudut. Ketiga konsep perbandingan, ke empat konsep kesejajaran, konsep luas, juga konsep perkalian.
P Kok konsep perkalian?
S Kalau konsep perkalian kan akan dibutuhkan pada saat menghitung luas dari taman bunga.

The second stage, orderliness of experience, the participant described strategy in solving the geometrical problem given. The participant explained the steps in choosing operation well related to the problem. For more clearly, the following is a transcript of the interview excerpt based on this stage.

P Baik, dengan informasi yang anda peroleh kira-kira strategi apa yang anda gunakan untuk meyelasaikan soal ini?
S Dari informasi yang diperoleh atau yang diberikan dari soal ini, pertama-tama yang saya kerjakan terlebih dahulu adalah menggambar pak.
P Apa yang kamu mau gambark?
S Eh, taman bunganya pak. Eh taman bermainnya pak. Saya menggambar bentuk taman bermainnya serta menggambar taman bunga yang ingin dicari luasnya pak.
P Ok. Sekarang, saya tanya lagi. Kamu kok menggambar? Padahal kan soalnya tidak menuntut kamu menggambar?
S Eh, bagi saya pada soal ini, memang tidak meminta saya menggambar. Tetapi, untuk memperoleh informasi yang lebih jelas, dan akurat. Saya kira kita harus menggambar terlebih dahulu, supaya kita bisa memahami dengan jelas, maksud dan tujuan dari soal ini.
P Ok. Terus setelah menggambar apalagi?
S Setelah menggambar saya, mencatat apa-apa yang diketahui dari soal pak. Contohnya, sudut yang diketahui dari soal yaitu sudut 45 derajat dan gambaran saya itu, saya mengumpukan bahwa sudut SPD itu 45 derajat.
P Sudut SPD?
P Ok. Terus apalagi?
S Saya, menuliskan juga apa yang ditanyakan. Pada soal ini kan yang ditanyai itu luas taman bunga. Pada penyelesaian ini, saya umpakan taman bunga sebagai persegi panjang PQRS.

The participant also can explain the difficulties when the participant tried to apply the strategy to solve the problem given. The following is a transcript of the interview excerpt based on this stage.

P Ok, sekarang, jadi kesulitan yang anda hadapi untuk menerapkan strategi ketika menyelesaikan soal ini adalah?
S Itu tadi pak, eeh, yaitu mengaitkan antara konsep satu dengan konsep lainnya, agar tidak terjadi kesalahan dalam pengerjaan. Misalnya yang tadi ini, konsep sudut dengan konsep segitiga. Konsep perbandingan pada ruas garis, kemudian mengaitkan konsep sudut.
P Maksudnya?

From the explanation above, it can be concluded that at this stage, the participant gave an explanation how choose a operation or strategy accurately and the participant can find difficulties and explain it related to the strategy chosen.

The third stage, evaluation of experience, the participant can find also strengths and weaknesses of solutions that had been done and explain how the effort to improve the weaknesses that are owned or carried when solving problems. For more clearly, the following is a transcript of the interview excerpt based on this stage.

ME-11
Coba kamu sebutkan kelebihan dan kekurangan terkait penyelesaiannya kamu lakukan.

Kelebihannya itu pak, bisa memudahkan informasi dari bentuk soal ke dalam bentuk gambar, bisa memberikan informasi yang lebih jelas lagi. Saya mudah mengeceknya kembali apabila mau dikrocek kembali dari awal karena penyelesaianannya saya itu secara rutinit. Kekurangannya mungkin butuh waktu yang agak lama karena harus lebih teliti. Contohnya saja tadi, karena saya kurang teliti terdapat sebuah kesalahan dalam pemilihan operasi, contohnya tadi itu, tadi saya tulis tambah, tapi setelah saya cek kembali, saya tahu kesalahan saya berada di situ.

Tadi itu kan kamu menyebutkan kelebihan dan kekurangan terkait penyelesaiannya kamu lakukan. Sekarang, kira-kira, upaya apa yang anda lakukan untuk mengurangi kelemahan ketika menyelesaikan soal?

Ehh, mungkin upaya yang saya lakukan yaitu, contohnya lebih konsentrasi dalam menyelesaian soal. Sekarang, kira-kira, upaya apa yang anda lakukan untuk mengurangi kelemahan ketika menyelesaikan soal?

Saya sudah betul, bahwa dalam menyelesaikan soal apapun itu bentuknya, seseorang harus lebih tenang, konsentrasi, dan rileks. Kemudian kita bisa berpikir lebih jernih dalam menyelesaikan soal.

From the transcript of interview above, it can be concluded that the participant can give the explanation about strengths and weaknesses from the solutions which had been done, namely the participant can formulate or transform from verbal to picture or other forms. On the other hand, the participant can explain the effort to revise and improve the weakness that are owned or carried when solving geometrical problems, for example; when the participant resolve any matter that are in any forms, the subject of research must be calm, concentration, and relax. Then we can think more clearly in solving geometrical problems.

The fourth stage, testing the selected solution based on the experience, the participant explained whether the answers or solutions which are obtained can answer the issues presented and explained how to test the internal consistency or error in operation or in the solution from the problem solving which had been done. For more clearly, the following is a transcript of the interview excerpt based on this stage.

Menurut Anda, penyelesaian yang anda lakukan ini telah menjawab permasalahan dari soal ini

Sudah pak.

Apa permasalahan dari masalah atau soal ini?

Permasalahan dalam soal inik menentukan luas taman bunga

Apakah kira-kira sudah menjawab permasalahan ini?

Sudah pak, pan permasalahan dalam soal ini adalah mencari luas taman bunga yang berbentuk persegi panjang yaitu saya mencari panjang dan lebar dari taman bunga dan saya sudah menemukan panjang dan lebar dari taman bunga, kemudian saya operasikan lalu akhirnya saya mendapatkan luas dari taman bunga ini.

Jadi yang anda lakukan untuk meyakinkan bahwa penyelesaian yang anda lakukan ini sudah menjawab pertanyaan dari permasalahan soal ini adalah?

Karena, untuk menentukan luas dari taman bunga ini, saya sudah mencari panjang dan lebar dari taman bunga ini kemudian panjang dan lebar dari taman bunga saya sudah temukan.

Tapi kamu yakin dengan panjang dan lebar yang kamu temukan itu?

Yakin pak.

Mengapa anda yakin dengan ukuran panjang dan lebar yang anda temukan itu?

Ehh, karena dari proses penyelesaian ini, setelah melihat kembali, dan mengecek kembali ini sudah, semuanya sudah memenuhi prosedur tetapi jika perlu saya akan menyelesaikan soal ini dengan cara yang berbeda.

Maksudnya dengan cara yang berbeda?

Ahh, kan bisa saja ini soal bisa diselesaikan dengan beberapa cara, untuk meyakinkan jawaban saya kembali. Saya bisa menggunakan cara yang lain untuk menyelesaikan soal ini dan apabila jawabannya sama, maka jawaban saya ini saya sangat yakin sudah benar.

Apanya yang anda bandingkan? Ketika anda menyelesaikan soal ini.

Ehh, jawaban terakhirnya pak. Luas taman bunga, apabila luas taman bunga yang saya peroleh sama dengan cara berbeda maka saya yakin ini sudah benar.

From the transcript of interview above, it can be concluded that the participant can give the explanation about the answers or solutions which are obtained from the solutions which had been done had answered the geometrical problem given, namely the participant can find the point from the problems (length and width of flower garden) which can help in finding the area of flower garden. Although, in the problem, the length and width are not mentioned specifically, the participant can find them and help the participant in solving geometrical problem or finding the solutions. Furthermore, to test the internal consistency or error in operation or in the solution, the participant checked and looked back related procedures and operations which is used. Moreover, the participant tried to resolve the problem in a different way to compare the answers which had been obtained before.

IV. CONCLUSION

From the results of this study, it can be concluded that the participant can solve the geometrical problem by using his reflective thinking in four stages. The four stages are:

1. The first stage, formulation and synthesis of the experience, the participant described problem by using his own word, the participant explained problem clearly related to the main point from the
problem. The participant also can find the concepts which are related to the problem given. Furthermore, the participant described the problem by using another word however participant’s explanation still has the same idea from the problem. Moreover, when the subject identified concept or subject matter which is related to the problem, the participant mentioned not only the concept that ever the participant used in solving a problem before, but also the participant explained that the concept which will be used in solving the geometrical problem.

2. The second stage, **orderliness of experience**, the participant described strategy in solving the geometrical problem given. The participant explained the steps in choosing operation well related to the problem. Further, the participant gave an explanation how choose a operation or strategy accurately and the participant can find difficulties and explain it related to the strategy chosen.

3. The third stage, **evaluation of experience**, the participant can find also strengths and weaknesses of solutions that had been done and explain how the effort to improve the weaknesses that are owned or carried when solving problems. It means that the participant can give the explanation about strengths and weaknesses from the solutions which had been done, namely the participant can formulate or transform from verbal to picture or other forms. On the other hand, the participant can explain the effort to revise and improve the weaknes that are owned or carried when solving geometrical problems. For example; when the participant resolve any matter that are in any forms, the subject of research must be calm, concentration, and relax. Then someone can think more clearly in solving geometrical problems.

4. The fourth stage, **testing the selected solution based on the experience**, the participant can give the explanation whether the answers or solutions which are obtained can answer the issues presented. In addition, the participant can explain how to test the internal consistency or error in operation or in the solution from the problem solving which had been done. For example, the participant checked and looked back related procedures and operations which is used. Moreover, the participant tried to resolve the problem in a different way to compare the answers which had been obtained before.

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