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Analysis of creative mathematic thinking ability in problem based learning model based on self-regulation learning

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Abstract. The purpose of this research identified the effectiveness of Problem Based Learning (PBL) models based on Self Regulation Leaning (SRL) on the ability of mathematical creative thinking and analyzed the ability of mathematical creative thinking of high school students in solving mathematical problems. The population of this study was students of grade X SMA N 3 Klaten. The research method used in this research was sequential explanatory. Quantitative stages with simple random sampling technique, where two classes were selected randomly as experimental class was taught with the PBL model based on SRL and control class was taught with expository model. The selection of samples at the qualitative stage was non-probability sampling technique in which each selected 3 students were high, medium, and low academic levels. PBL model with SRL approach effectived to students' mathematical creative thinking ability. The ability of mathematical creative thinking of low academic level students with PBL model approach of SRL were achieving the aspect of fluency and flexibility. Students of academic level were achieving fluency and flexibility aspects well. But the originality of students at the academic level was not yet well structured. Students of high academic level could reach the aspect of originality.

1. Introduction

The need for creative people was a necessity in the modern era, so Bart et al. [1] argue that creative was becoming an increasingly important area especially in education. According to Ervynck [2] that creative enabled students to achieve the most important characteristics of advanced mathematical thinking. Shriki [3] argued that mathematical creativity at the school level did not expect exceptional creative work, but can offer new insights into mathematical problems that was appropriate for students. Creativity in mathematics according to Chamberlin and Moon [4] was defined as an unusual ability to produce novelty and useful solutions to simulate and apply to real problems using mathematical modeling.

Creativity was closely related to creative thinking. Creativity was the result of the creative thinking process. While the ability to think creatively mathematically was the ability to find solutions math problems that were easy, flexible, and new. There was in line with indicators of mathematical creative thinking according to Mann [5] and Tok et al. [6] is fluency, flexibility, and originality. Akgul [7] developed the test of mathematical creativity by indicating aspects of fluency, flexibility and originality. These aspects of creative thinking were used to measure students' mathematical creative thinking skills.

Exploring the ability of mathematical creative thinking need to be developed a model of learning that was able to find solutions math problem solving that was easy, flexible, and contains elements of novelty. Problem Based Learning (PBL) is considered to support the development of creative thinking

skills mathematically. PBLs enabled students to achieve equal or greater achievement on standardized testing when students were taught by direct instruction [8] and for better problem-solving and retention of long-term knowledge. Studies even showed that PBL was more effective for students with low student ability [9]. PBL was dominated by student activities so that students can gain experience and knowledge through the learning process, while the role of the teacher was more as a facilitator.

Learning based on student-centered learning principles requiring knowledge and self-confidence, motivation, goals and strategic knowledge, were indication of Self Regulated Learning (SRL). The SRL on cognition and behavior was an important aspect of learning and the extent to which school students became self-regulators of their own learning affect their academic success [10]. Based on the above description, the purpose of this research was identifying the effectiveness of PBL model based on SRL on the ability of mathematical creative thinking and to analyze the ability of mathematical creative thinking of high school students in solving mathematical problems.

2. Methods

The population of this study was students of grade X SMA N 3 Klaten. The research method used in this research was sequential explanatory. the selection samples of the qualitative stage with non-probability sampling technique selected each level was 3 students with high academic, medium, and low. The nine students were observed the stages of mathematical creative thinking in solving the question of mathematical creative thinking. Students were interviewed with semi-structured interview techniques to obtain validity of data. Students were given tests of mathematical creative thinking with trigonometric material to measure the ability of mathematical creative thinking. While the affective ability of motivation and independence of learning is measured by filling in a questionnaire by each student and observation by the researcher.

3. Results and Discussion

Students of the experimental class have differences in the ability of creative thinking mathematically each level of academic this be seen based on the results of interviews to each individual. Figure 1 showed the variation of the answer to determine the extent of the parallelogram if the lengths of the sides of the parallelogram and the angle flanking the sides of the parallelogram were shown. Experimental class students with high, medium, and low academic ability could solve the problem smoothly and by using various solutions. Although with different problem solving strategies, they could find the same answer correctly. Figures 1 (a), 1 (c), and 1 (d) showing that students divide parallelogram into two equal triangles, then determine the extent of the parallelogram by calculating the area of the multiplied triangle. Figures 1 (a), 1 (b), and 1 (d) determined the height of the parallelogram to calculate the width of the parallelogram by using the high base formula. Figure 1 (b) showed that the student determined the height of the parallelogram by using the sinus rule, then checks it using the cosine rules.

Students of the experimental class, especially at the lower academic level, could not determine the solution correctly as shown in Figure 2 (a). Figure 2 (a) shows how the wrong completion steps. This can be because students can not understand the problem correctly even though the student has chosen the correct problem solving strategy. This can be because students can not understand the problem, as evidenced by the students are not able to write the data include the elements that were known and the question of the problem. Unlike experimental class students at high and medium academic levels who can understand the problem by drawing a triangle-building sketch according to the information on the issue, write down the elements that are known clearly and write down the question of the problem. So that high and medium level academic experiment class students can determine the exact solution strategy and apply it to obtain the correct solution as shown in Figure 2 (b).

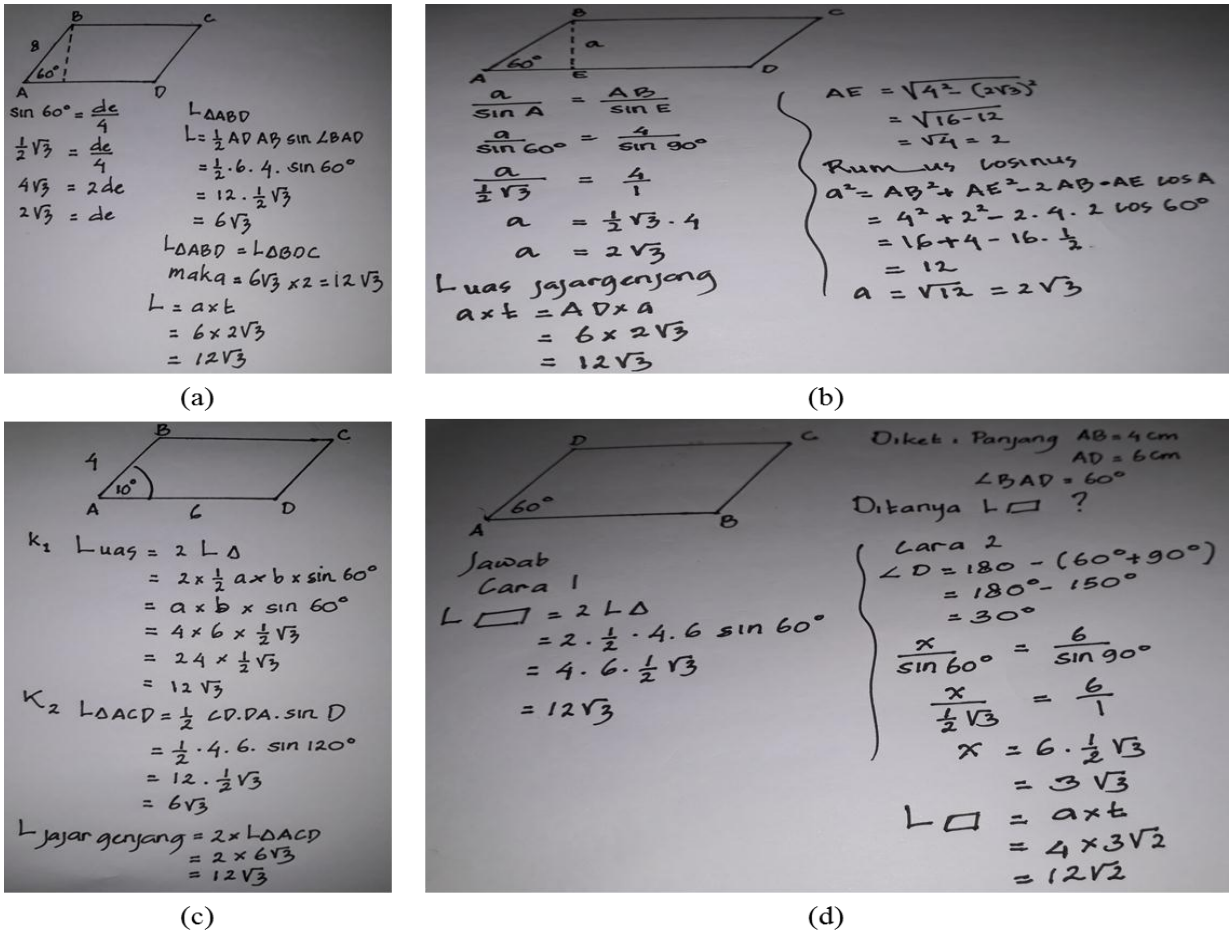
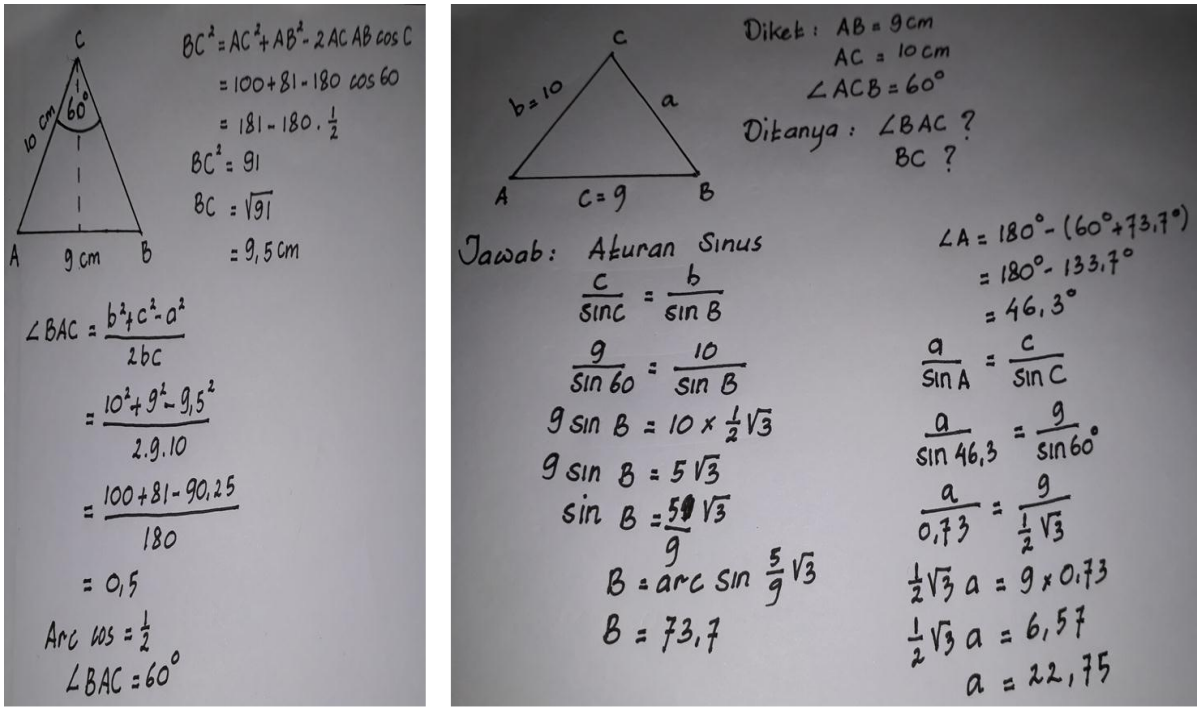


Figure 1. Results of Creative Thinking Ability Test Determining Area Mathematical Problem parallelogram

Figure 3 showed various ways of calculating the area of a triangle if the triangle is constructed from the coordinate meeting of the points on a quadratic function. Most students, especially students with medium and low academic levels, determine the area of the triangle by using the triangle area formula that is LΔ = 1/2 × base height × height, as seen in Figures 3 (a) and 3 (b) without checking the result with Using other solution solutions. Students with high academic ability can determine the area of the triangle in Cartesian coordinates with some solutions. The first solution of completion, the student determines the area of a triangle with the commonly used formula as in Figure 3 (a). As for the second solution, students use triangular area to calculate the length of the triangle's sides then using the triangle area formula as shown in Figure 3 (c). The second solution is still very rarely used by students let alone determine the length of the sides of the triangle with if known two angle coordinates of course was a new thing for students and not every student is able to think that far. Students claimed to know the formula from some reference books he had ever learned.



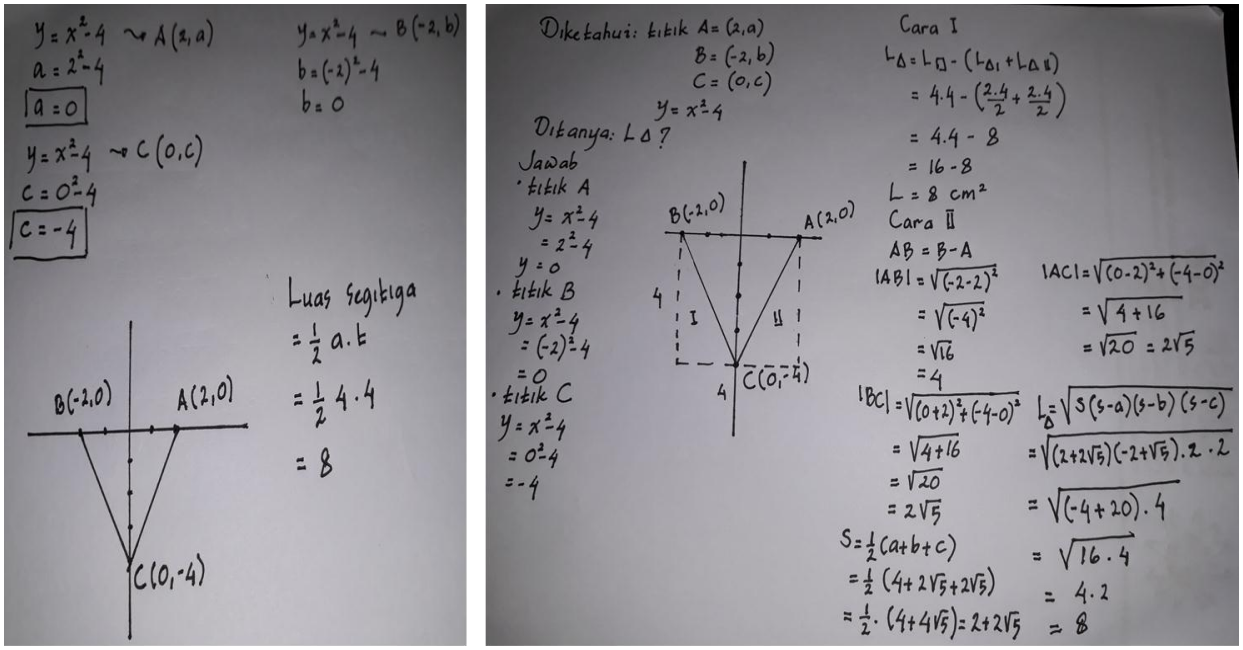
(a) (b)

Figure 2. Test Results of Creative Thinking Ability Mathematically Problem Determining the Elements of Triangle

The ability of mathematical creative thinking of low academic level students with PBL model of SRL approach able to achieve the smooth aspect and some low level academic students have been able to reach the aspect of the flexibility. This is shown from the ability of students to be able to determine the strategy of problem solving correctly. As a low level academic student also has been able to determine various problem solving strategies. Understanding the problem plays a very important role in the creative process as according to Baran et al. [11]. Students of academic level were also only able to achieve smoothness and flexibility aspects well. But the originality of students at the academic level was not yet well structured. Students at the academic level were already trying to find a new settlement strategy but the end result was not right. This can be caused by the accuracy of the students.

In contrast to high academic level students who are already able to build unusual ideas, intelligent ideas that was different from the way in general. Therefore, students of high academic level have been able to reach the aspect of originality which is the highest aspect in the ability of mathematical creative thinking. As Akgul and Kahveci [7], Sak and Maker [12] made an assessment of the creative thinking ability of providing the highest score to students who were able to provide problem solving strategies in an unusual or unique way. So it can be said that the academic level has a relationship with the ability to think creatively mathematically. This was in line with Tyagi [13] which showed that a significant causad relationship between mathematical skills and mathematical creativity.

The difference between students in the class with the PBL model of the SRL approach and the students in the classroom with expository learning were the steps in achieving mathematical thinking ability especially in low and middle level academic students. Students with the PBL model of the SRL approach can in detail solve the problem by going through the following stages: (1) finding stages of objectives, finding data or facts and finding problems as target questions; (2) determining many possible ideas; and (3) developing an appropriate choice of ideas. The creative process is in line with Treffinger and Isaksen [14].



(a) (b)

Figure 3. Test Results of Creative Thinking Ability Mathematically Problem Determining Area of Triangle

4. Conclusion

The ability of mathematical creative thinking of low academic level students with PBL model of the SRL approach was capable of achieving the smooth aspect and some low level academic students have been able to achieve the aspect of the flexibility. Students of academic level were also only able to achieve smoothness and flexibility aspects well. But the originality of students at the academic level was not yet well structured. In contrast to high academic level students who were already able to build unusual ideas, intelligent ideas that were different from the way in general. Therefore, students of high academic level have been able to reach the aspect of originality which was the highest aspect in the ability of mathematical creative thinking.

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