Mathematic creative thinking ability based on student metacognition in blended learning model with e-module

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Abstract. The objectives of this study are 1) to find out how the effectiveness of the Blended Learning model with E-Module in improving creative thinking skills. 2) Describe the ability to think creatively in terms of students' metacognition. This research is a mix method research with a sequential explanatory design that combines quantitative analysis and qualitative analysis. Quantitative analysis is used to determine the effectiveness of the Blended Learning model while quantitative analysis is to determine the creative thinking process in terms of students' metacognition. The research subjects were students of class X SMA Negeri 1 Salatiga. The results showed that the Blended Learning Model with E-Module was effective for increasing students' creative thinking abilities. Qualitative analysis showed that students with high metacognition were able to meet all the criteria for creative thinking abilities including fluency, flexibility, novelty and elaboration. Students with moderate metacognition cannot meet all indicators of creative thinking ability, students still have difficulty in flexibility and novelty indicators. Students with low metacognition have many deficiencies in fulfilling creative thinking skills, only fluency indicators can be fulfilled properly by these students. Based on these results, it shows that metacognition has a role in students' creative thinking abilities.

1. Introduction
The ability to think creatively is a pillar of mathematics learning and its implementation in learning depends on the teacher implementing it in the classroom [1]. Creativity not only increases students' understanding of learning material but also prepares students to learn mathematics applications in other fields [1]. Creativity is bringing up new imaginative ideas which include new innovations or different solutions to a problem, and a different problem formulation [2]. Creativity is the ability to produce new, surprising, and interesting (high-quality) ideas or products [3]. Creativity as a process intended to realize possibilities in various forms, and produce new breakthroughs in the fields of science and technology [4]. Characteristics of mathematical creativity in the context of problem finding, invention, independence, and originality have applied the concepts of fluency, flexibility, and originality [5].

Torrance states that the definition of creativity consists of four interrelated components, namely fluency, flexibility, novelty, and elaboration [6]. Fluency, related to the continuity of ideas, the relationship between knowledge, and the use of basic and universal knowledge. Flexibility, associated with a variety of ideas, to solve a problem in various ways, and produce various solutions. Novelty, characterized by a new and unique way of thinking resulting from mental or artistic activity. Elaboration, refers to the ability to describe, explain, and generalize ideas.
The ability to think creatively is indirectly related to the ability of students to solve math problems at school. Psychological aspects, namely affective abilities also affect students in creative thinking. One of the affective abilities that affect the ability to think creatively is metacognition. Metacognition is a person's knowledge of their own information processing skills, as well as knowledge of cognitive abilities and strategies to solve a problem, including specific skills related to monitoring and self-regulation of one's cognitive activities. Metacognition is a process by which an individual monitors ongoing cognition so that it can effectively control his or her behavior [7]. Metacognitive proficient students can organize themselves in advance by reading math commands and problems to understand the information provided and find out what is required of the questions. Furthermore, students relate the prior knowledge needed to understand and solve problems. Before acting, they set goals and devise a follow-up plan [8].

Three main aspects of metacognition, namely metacognitive knowledge, metacognitive experiences, and metacognitive skills, which are strategies for controlling cognition. Metacognitive knowledge refers to segments of "general knowledge" that have to do with human thoughts and actions. Metacognitive experiences refer to a person's awareness and feelings that arise in problem-solving situations (for example, a feeling of knowing), and metacognitive skills play a role in a wide variety of cognitive activities such as verbal explanation, reading comprehension, attention, and remembering.

Learning systems are increasingly developing in the 21st century, learning is not only done in the classroom with face-to-face or conventional learning but can be done with other media based on the use of information technology. Blended learning is a learning model that combines offline and online learning. Blended Learning is learning that combines face-to-face (offline) learning with virtual / online (offline) learning. Blended learning is a combination of several methods, pedagogical approaches or technology that are combined into a single learning unit [9]. Blended learning can support learning outside the classroom. Thus, because teachers and students have limited time in class, they can continue learning online by using discussion media or other media [10]. The combination of face-to-face learning and online learning or often called hybrid learning is more effective than conventional learning than fully face-to-face learning and fully online learning [11]. Online-based online learning uses an approach to students [12]. The approach to students will make it easier for students to understand the learning flow [13][14]

The utilization of the Blended Learning model is combined with the E-Module. E-Modules are teaching materials that are arranged systematically in language that is easy for students to understand according to their level of knowledge and age, so that they can learn independently with minimal help from educators. The strategy for organizing learning material in the module contains sequencing and synthesizing. The e-learning module contains learning material, quizzes, practice questions, learning videos, then learning evaluation.

The goals of this research are (1) finding out the learning effectiveness in the implementation Blended Learning Model with E-Module toward students creative thinking ability; (2) describing creative thinking skills on Blended Learning Model with E-Module viewed by students' metacognition.

2. Methods

This research is a combination research using the Concurrent Embedded design that combines quantitative methods and qualitative methods by mixing the two methods unequally [15]. Qualitative aspects are more emphasized and quantitative aspects are supporting data to analyze creative thinking skills associated with students' metacognition, then analyzed quantitatively and then described qualitatively.

The population of the study were 10 grade students of SMA Negeri 1 Salatiga with 10 classes. The research sample used 2 classes from the population with the condition that they have the same average ability. One class is used as a trial class for the Blended Learning model with E-Module, while one class is used as a control class using the PBL learning model.

Quantitative analysis includes testing the effectiveness of the Blended Learning model with E-Module as evidenced by 1) individual completeness 2) classical completeness of the experiment class
3) The average creative thinking ability in the experiment class is better than the control class 4) the proportion of creative thinking ability in the model Blended learning is higher than the proportion of control class learning.

Qualitative analysis is by taking 6 research subjects from experimental class students who meet high metacognition, moderate metacognition, and low metacognition. Then interviewed regarding the ability of creative thinking triangulation and then the data are the data analysis Carried out using the data validity, data reduction, presentation and verification of the Data.

3. Results and Discussion

3.1. Effectiveness of Blended Learning

3.1.1. Individual completeness. Completeness of individuals based on test Based on the students' creative thinking skill average test applied to the T-test. The researcher used Microsoft Excel in obtaining the result while so \( z \text{count} > z \text{table} \). It means that the average value of students' creative thinking skill in the experiment class reached the standard of minimum completeness of mastery learning.

3.1.2. Classical completeness. Proportion test is used to test students' completeness classically. Learning is said to be successful if 75% of all students can get a KKM score of 70. The experimental class consisted of 30 students with an average value of 77.63 creative thinking skills. Using the \( z_{\text{test}} \) calculation using the Microsoft Excel application, the \( z_{\text{count}} = 1.83 \) while the \( z_{\text{table}} = 1.65 \) so that \( z_{\text{count}} > z_{\text{table}} \), it can be said that 75% of students in the experimental class are classically complete.

3.1.3. Average difference test. The average result of the creative thinking ability test in the experimental and control classes is and with the variance, respectively. The calculations were carried out with the help of Microsoft Excel software until they were obtained and, so it could be stated that the average creative thinking ability of the experimental class was more than the average creative thinking ability of the control class.

3.1.4. Proportion test. The results of the calculation, it is found that the value and it can be concluded that \( z_{\text{count}} > z_{\text{table}} \) which means that \( H_0 \) is rejected, so it can be concluded that the proportion of students completing the KKM in the class taught by the Blended Learning model with E-Module more than the proportion of students completing the KKM in the class taught with the PBL model.

3.2. Students creativity skills based on metacognition.

Students' creative thinking abilities are described based on the students' metacognition which is classified into high metacognition, medium metacognition, and low metacognition. The analysis was carried out by conducting in-depth interviews with subjects that had been selected based on previous classifications and analyzed with the creative thinking ability scheme, namely fluency, flexibility, novelty and elaboration.

3.2.1. Students with high metacognition. Students with high metacognition meet all the criteria for creative thinking abilities which include fluency, flexibility, novelty and elaboration. On the fluency indicator students can pursue a coherent and clear flow of work, can write information about the work in the questions. While on the flexibility indicator, students can work on questions in more than one way, and come up with the same solution. this shows that students have a good understanding of the material being taught. Novelty indicators are fulfilled when in the process students can work on their own way /thinking. The elaboration indicator is shown in the results of work and interviews with both subjects. The process of working on the two subjects has complete information, a sequential completion process, and at the end of the work there is also a conclusion that the completion bag is clearly arranged
so that it is easy to understand. The results of the interview also show that the subject evaluates and checks the questions that have been worked on so as to minimize errors in understanding the questions and the final results.

Figure 1. Steps to work with students with high metacognition

3.2.2. Students with moderate metacognition. Students with moderate metacognition cannot fulfill all indicators of the ability to think creatively properly. There are several indicators that do not meet the criteria. On the Fluency indicator students can write and explain well, in this indicator students can understand the problem well. Students' flexibility indicators have difficulty finding other ways to solve math problems. Students can only solve the problem by using one method although there are many possible ways that can be used to solve the problem. The novelty indicator for students can bring up the novelty of the method but it is still unclear and produces the right solution. The results of the interview showed that the students understood the problem but still experienced difficulties. On the elaboration indicator students can provide conclusions in the process and check again after completing work.

Figure 2. Steps to work with students with moderate metacognition

3.2.3. Students with low metacognition. Students with low metacognition cannot meet the four criteria for the ability to think creatively well. The fluency indicator is the indicator most students can fulfill, in this indicator students understand math problems and can write down the methods used to solve them. In the fluency indicator, students are included in the good category. Flexibility indicator, students have difficulty in finding solutions in more than one way, from the results of the interviews students say they have difficulty finding these other ways. Students tend to memorize the formulas in solving problems so that it becomes difficult when they encounter problems with many possible works. In the novelty indicator, students are not able to come up with new ideas or ideas in the problem solving process, students have a habit of memorizing formulas and the flow of their solutions so that it is difficult for the novelty of students to emerge. In the elaboration indicator, students do not evaluate or check back on the work so that in the process of work there is no improvement if errors are found during the calculation process or steps to solve it.
Generally, Students with low metacognition cannot meet the four criteria for the ability to think creatively well. The fluency indicator is the indicator most students can fulfill, in this indicator students understand math problems and can write down the methods used to solve them. In the fluency indicator, students are included in the good category. Flexibility indicator, students have difficulty in finding solutions in more than one way, from the results of the interviews students say they have difficulty finding these other ways. Students tend to memorize the formulas in solving problems so that it becomes difficult when they encounter problems with many possible works. In the novelty indicator, students are not able to come up with new ideas or ideas in the problem solving process, students have a habit of memorizing formulas and the flow of their solutions so that it is difficult for the novelty of students to emerge. In the elaboration indicator, students do not evaluate or check back on the work so that in the process of work there is no improvement if errors are found during the calculation process or the completion steps. In several previous studies also concluded that metacognition has an impact on the ability of individuals to think creatively[16][17].

4. Conclusion
The results of the quantitative analysis show that the Blended Learning model is effective in increasing the ability to think creatively by meeting the following criteria: 1) The average student has the ability to think creatively individually as shown by the minimum completeness limit (KKM) of 70; 2) students 'creative thinking ability fulfills classical completeness with 75% of the total students' minimum completeness limit (KKM); 3) the average creative thinking ability in the class with the Blended Learning (experiment) model is better than the class with the PBL model (Control class); 4) The proportion of the class creative thinking ability with the Blended Learning (experiment) model is more than the proportion of the class with the PBL model (Control class).

Students' creative thinking ability with high metacognition fulfills all indicators of creative thinking ability, students understand mathematical problems being worked on, can write the flow of problem solving systematically, are able to come up with solutions in more than one way, and carry out evaluations at the end of the work. Students with moderate metacognition cannot meet all indicators of creative thinking abilities, students have difficulty finding more than one solution and novelty when working on questions. Students with low metacognition are only able to meet one indicator of the ability to think creatively, namely fluency, students understand problems but are limited to memorizing problem solving, so that they experience difficulty in providing other solutions, novelty indicators are not met, and there is no evaluation at the end of solving the questions.

In general, the Blended Learning model is effective in increasing students' ability to think creatively, but students' creative thinking abilities also depend on metacognition which affects students' abilities.

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