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Application of the Blended Learning Model to Improve the Mathematical Creative Thinking Skills of GeoGebra-Assisted Junior High School Students in Mathematics Lessons

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Abstract: In terms of learning and academic level, this study compares the development of mathematical creative thinking skills between students who use the Blended Learning Model with GeoGebra support (BLM-G) and students who use the Blended Learning Model without GeoGebra aid (BLM-non-G). A nonequivalent control-group design and a quasi-experimental research methodology are being used. The participants in this study were eighth-grade SMPN students in Ternate City, Indonesia. The research sample was 125 people from two schools with different grade levels. The instrument used is a mathematical creative thinking ability test. Research result; Learning using BLM-G influences students' mathematical creative thinking abilities at high and medium school levels, with very high categories. When compared to kids who learn using BLM-non-G learning, students who use BLM-G learning exhibit greater growth in their capacity for both mathematical and creative thought. This is based on high school level pupils. Kids who study using BLM-G learning and students who learn using BLM-non-G learning exhibit equal increases in their capacity for mathematical and creative thought at the middle school level.

Keywords: *Applied GeoGebra, blended learning model, mathematical creative thinking ability.*

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Introduction

The development of education in the 21st century is designed into the national education curriculum with the aim of creating a productive, creative, innovative, and effective generation that can integrate attitudes, skills, and knowledge that can be applied in the life of society, nation, and state (Dwivedi & Joshi, 2021; Heasly, 2021). Creating a productive, creative, innovative, and effective generation can be developed through high-level thinking skills, namely the ability to think creatively (Smith, 2022). Through education, one can improve their ability to think. Students are required to study something abstract, and because of this, they are compelled to be productive, creative, and innovative in their problem-solving (Huan et al., 2022). All educational levels, from secondary to higher education, can benefit from developing pupils' mathematics creative thinking skills. When taught utilizing the proper learning methodologies to alter the intended student behavior, the development of mathematics creative thinking abilities can be successful (Hidajat, 2021; Maryani et al., 2022).

Problem sensitivity, open-mindedness, and the capacity to discover connections in problem resolution are all characteristics of creative thinking, which is a mental activity. Creative ability is generally understood as creativity. Often, individuals who are considered creative are outstanding synthetic thinkers who make connections between things that others do not spontaneously notice. In order for students' creativity to materialize, encouragement is needed within the individual (intrinsic motivation) as well as encouragement from the environment (extrinsic motivation) (Casing & Roble, 2021; Inweregbuh et al., 2020).

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According to the Trends in International Mathematical and Science Study (TIMSS) and the Program for International Student Assessment (PISA), Indonesian students perform the worst or perform below average internationally for mathematics tasks requiring higher-order thinking skills. Indonesian junior high school students' problem-solving skills and high-level thinking (creative thinking) abilities are still below those of their neighbors (Malaysia, Singapore, and Thailand), which makes it difficult for them to answer non-routine questions about logic, generalization, making hypotheses, and finding connections between the facts provided (Egan et al., 2022; Sjøberg & Jenkins, 2022).

(Ndiung et al., 2021) discovered that students who study mathematics using the RME approach and the Treffinger learning model score better on learning outcomes and in terms of their capacity for creative thought than students who study the same topics using traditional learning. A similar study (Jumadi et al., 2021) looked at how well students' capacity for creative thought was improved by using Google Classroom to facilitate project collaboration. The findings revealed a substantial difference in the level of creative thinking ability between project collaboration models facilitated by Google Classroom. The best option for developing creative thinking skills is the project collaboration model supported by Google Classroom. To handle challenges requiring innovative thinking, instructors and policymakers may prefer to learn using a collaborative project approach with Google Classroom's assistance.

Given the findings of the TIMSS and PISA studies as well as studies of several undergraduate students, a learning model is needed that can increase students' creative thinking capacity to improve creative thinking skills. The approach proposed is the blended learning model (BLM). BLM is a model of learning that combines two learning philosophies or techniques, and it can aid students in developing their capacity for both quantitative and creative thought. According to Sutisna (Kesuma et al., 2020), who was able to support this claim, BLM incorporates a number of learning models or strategies in order to accomplish its objectives. The key to BLM starts here and is primarily determined by the models combined.

Mixed learning indoors and outdoors using a rotational blended learning lab is the form of BLM used in this study. The mixed learning approach, which places equal emphasis on physical and digital environments outside of the classroom, starts and ends there. For the rotation blended learning lab model, each meeting's learning can be broken up into numerous portions, and a computer lab is necessary. The realistic mathematics education (RME) approach can be used to link BLM by integrating mixed learning inside and out with a rotation blended learning lab. According to experts, the RME approach starts learning with the learning experiences and realities of the pupils. Students can strengthen their mathematical creative thinking skills by applying real-world experiences to their learning, particularly when learning mathematics (Iskandar & Juandi, 2022; Samura & Darhim, 2023; Sundaram & Ramesh, 2022).

In two schools, the two forms of BLM are used at various levels. The results of the mathematics national test can be used to determine a student's grade in school. Based on school accreditation scores and math test results from the national level, the level of schools in the high category is decided. The school is classified as a high category school due to its excellent math results and excellent accreditation scores. Contrariwise, for schools in the medium category (Samura & Darhim, 2023).

One feature that can be utilized to learn mathematics is GeoGebra. This software is a tool for learning geometry, algebra, and calculus, which can be displayed concurrently through text and graphic windows, where this feature aids students in developing and solving mathematical issues (Zulnaidi et al., 2020). Math, geometry, algebra, and calculus can all be learned with GeoGebra, which is incredibly effective. With the use of this software, students can better understand abstract ideas and connect diverse mathematical ideas to real-world situations. The construction tools and menus in software are simple to use. The software can be examined and used independently by teachers or students (Samura et al., 2021)

There are many different types of explanations offered, so the researcher can use this information to formulate the following research questions in the formulation of the problem: Does the Blended Learning Model with GeoGebra (BLM-G) affect junior high school students' capacity for both creative and mathematical thought when learning mathematics? In terms of learning and academic level, is there a difference between students who take the Blended Learning Model assisted by using GeoGebra (BLM-G) and those who take the Blended Learning Model not using GeoGebra (BLM-non-G) in terms of increasing their capacity for creative and mathematical thinking?

The researcher plans to perform a thorough investigation into the capacity for creative and mathematical thought utilizing GeoGebra-assisted BLM using the various descriptions mentioned above. A thorough investigation is anticipated for the research project "Application of the Blended Learning Model to Improve the Mathematical Creative Thinking Ability of GeoGebra-Assisted Junior High School Students in Mathematics Lessons."

Literature Review

Mathematical Creative Thinking Ability

The definition of " creative " has various meanings depending on the experts who define it. No expert definition is used as a patent to be standardized. The definitions of creative from experts have interrelated meanings. According to the Big Indonesian Dictionary (BID) online, the word creative means having the ability to create or is (contains) creativity; in other words, a job that requires intelligence and imagination. Referring to the BID above, it can be defined as creative, which means having creativity and realizing ideas and feelings so that a composition with new colors and nuances is formed. When someone does something (work) and produces a product from work itself which is considered to produce artistic value, that person is called creative. To see creativity is not limited to products that produce artistic value, this is a tough challenge for educators (mathematics teachers) to create students using their brains and reason to be creative in the field of education, especially in mathematics (Forte-Celaya et al., 2021; Keleş, 2022).

Creativity can produce creativity. Creativity in producing a product of any kind will go through the formation of creative ideas. Good cognitive abilities will produce good creative ideas too. A person's good intelligence will affect the creative ideas that person has. Intelligence is very decisive in forming creative ideas. Creative and creativity are two words that cannot be separated because creativity itself is formed by creativity, which means making new things without combining something that already exists, "the ability to create" (Smith, 2022). Creativity can be needed in the learning process in the classroom. Students need the creativity of the learning process to go well as desired. Creativity obtained by students can be developed by applying divergent thinking. Divergent thinking, that is, in solving problems, especially in mathematics problems, students are asked to use non-procedural or non-formal methods by looking at the other side of the mathematical problem (Ali et al., 2021).

Divergent thinking is a solution to solving math problems by using ideas and ideas in various ways to get maximum results. Mathematics can function to develop creative thinking skills that are systematic, logical, creative, disciplined, and effective in collaboration in a modern and competitive life. The point is that learning mathematics can develop students' ability to think creatively. Learning mathematics can construct a logical, analytical, and systematic mindset. All of this results in the formation of individual abilities, which can be applied to life with entire competition in modern life (Purnomo et al., 2021)

(Suherman & Vidákovich, 2022) Defines creative thinking, namely the process of thinking to increase possibilities, postpone consideration, provide new and unusual possibilities, use imagination and intuition abilities, develop and choose alternatives, and have many ways and use points of view or answers something different. From this opinion, creative thinking is a mental activity related to sensitivity to problems, considering new information and unusual ideas with an open mind, and making connections in solving these problems. Creative ability is generally understood as creativity. Often, individuals who are considered creative are outstanding synthetic thinkers who build connections between things that other people do not realize spontaneously (Tamur & Juandi, 2020).

The ability to think creatively that everyone has will only appear by itself with going through some practice. The teacher is fully responsible for training and honing students' creative thinking skills by raising non-routine everyday problems in the learning process. Routine problems are problems that repeat the solution procedure. At the same time, non-routine problems are problems whose solution procedures require planning for completion, not just using formulas and theory (Rahayuningsih et al., 2021).

Methodology

Research Design

Quantitative research, using quasi-experiments, was designed using nonequivalent control groups by applying a blended learning model assisted by GeoGebra. This study has one independent variable, namely learning with BLM assisted by GeoGebra, and one dependent variable, increasing students' mathematical creative thinking abilities. The following shows the nonequivalent control-Group design research picture (Creswell, 2015).

O	*X*	*O*
O		*O*

Figure 1. Differential Control-group Design

Information

O; Pretest, and Post-test

X; Blended Learning Model Learning with GeoGebra.

Based on Figure 1, it can be explained that before being given treatment at both school levels, a test was first presented as a pretest (O) to know students' initial abilities about mathematical creative thinking abilities. After the pretest was completed, treatment was given. For the experimental class, GeoGebra-assisted BLM (X) was applied, while the control class did not use GeoGebra BLM. During the learning process, students' study in small groups according to the steps in BLM (outside-in blended learning) using the RME approach. The researcher held five meetings at all school levels in this learning activity. Once the treatment is complete, the next step is to give a posttest (O), to know whether, during the learning process, the learning model used can influence students' mathematical creative thinking abilities.

Sample and Data Collection

Two schools were chosen as the sample sites for this study, one in the high-level category and the other in the medium-level category. As test subjects, two classes from each of the two institutions were chosen. One is the experimental class, while the other is the control class. There are 62 middle school samples and 63 high school samples available. 125 persons make up the entire sample.

Instrument Development

The instrument used in this study is a matter of mathematical creative thinking ability tests directly related to teaching materials. Before the test questions are used, validity and reliability tests are first carried out. This validity test was carried out by a mathematics teacher with a background in a mathematics education master's degree which was conducted for one week. The teacher was asked to validate the test questions in terms of the face and content of the questions with the aim of seeing the editorial readability of the instrument. The face and content validity results were then tested using the Q-Cochran test to determine the validation results' uniformity. The readability test was also carried out on several students of State Middle Schools in Ternate City. The student is given a question to see whether the question can be adequately understood by the student regarding the intent of the question. The subsequent validity is empirical, where the test questions are given to a group of students in a representative school with a research sample. This validation is carried out to obtain validity and reliability.

Analyzing of Data

Test results for both creative and mathematical thinking were analyzed in this study, and the results were then quantitatively analyzed using a number of statistical tests. The normality and variance homogeneity tests were first carried out before deciding on the statistical test. We'll go over the procedures in data processing in more depth. The completeness of the data was examined initially before processing. Following the collection of the data, this phase is completed. The quality of the data is checked as the next phase. In order to complete this stage, it is necessary to determine whether the informants' responses match what the researcher had anticipated—that is, whether all columns are filled in or all questions are well addressed. Determine the missing data and whether it's essential to look for more data to determine the data quality. The following phase is calculation after all the data has been deemed complete. calculations performed as follows:

a. Calculating, using Hake's Normalized Gain (Samura et al., 2022), how much pupils' ability to think creatively and mathematically improves.

   The Gain index conditions are not present.

Table 1. Criteria for Normalized Gain Scores

Normalized Gain Score (g)	Interpretation
$g \geq 0,70$	High
$0, 30 \leq g < 0,70$	medium
$g < 0, 30$	Low

b. Determine the minimum, maximum, average, and standard deviation of the pretest, post-test, and Gain scores in descriptive statistics. Descriptive statistical analysis doesn't make inferences about the population; it just gives a general picture of the sample.

c. Estimating Cohen's effect sizes to determine the impact of BLM-G instruction on students' capacity for mathematical creativity (Samura & Darhim, 2023).

   Cohen'sd impact size classification is used to convert the value of (Yohannes et al., 2021), according to Table 2 below.

Table 2. Identifying Cohen's Effect Sizes

Effect Size	Criteria
$0,00 \leq ES < 0,20$	Very small
$0,20 \leq ES < 0,50$	Small
$0,50 \leq ES < 0,80$	Currently
$0,80 \leq ES < 1,30$	High
$1,30 \leq ES$	Very Big

d. Inferential statistical analysis was used to analyze the data.

   1. Examine the requirements for parametric statistics using data on developing mathematical creativity. Data are categorized according to learning and academic level (high and medium). Several tests that match the properties of the data can employ inferential statistical analysis (normal distributed, and homogeneous). This

phase involves testing the study's proposed hypothesis. Inferential statistical analysis includes the following stages, among others:

2. The Mann-Whitney test, Cohen's d test, two-way ANOVA test, and t test are all used to evaluate the hypothesis.
3. Non-parametric statistics can be used to conduct analysis on data that are not normally distributed.

Findings/Results

The results of examinations of junior high school students' mathematics creative thinking abilities provided the quantitative data for this investigation. Pretest and post-test data are two categories for the quantitative data. To compare results and gauge the influence of BLM-G, the pretest and posttest data can be utilized to calculate the N-Gain and Cohens's (d) value. The statistics on mathematical creative thinking abilities based on learning and academic level are shown in Table 3 and are described below.

Table 3. Data Description of Creative Thinking Ability Test Mathematics based on Learning and School Level.

School Level	n	Statistics	BLM-G Learning			BLM-non-G Learning		
			Pretest	Post-test	*N-Gain*	Pretest	Post-test	*N-Gain*
Tall	63	Max	25	67	0,65	25	60	0,57
		Min	6	20	0,14	5	20	0,16
		Mean	11,9	37.13	0,2865	11,13	30,28	0,2167
		S	5,192	14,236	0,15561	5,558	11,309	0,1111
Currently	62	Max	21	65	0,62	25	60	0,57
		Min	5	22	0,03	5	20	0,06
		Mean	11,25	33,56	0,2496	10,6	30,33	0,2194
		S	4,6	12,104	0,1414	5,556	11,327	0,1216
Ideal Maximum Score: 80								

Table 3 shows that students who had taken BLM-G lessons had a different capacity for mathematical creativity than students who had taken BLM-non-G lessons prior to the pretest learning. After instruction was completed, the average post-test score for high school students who took part in learning utilizing BLM-mathematical G's creative thinking skills was 37.13. The post-test score for the group of students that used BLM-non-G in their learning was 30.28. Students who study with BLM-G have a higher average score than those who study with BLM-non-G when compared to post-test results at the high school level. According to the average scores for children who participated in BLM-G learning and BLM-non-G learning, there was a 0.2865 and 0.2167 improvement in math and 0.2267 improvement in creative thinking, respectively. The average increase between the two trials differs by 0.0698. The two students in high school had different distributions of their data.

Same treatment at the middle school level. The average pretest score in each learning class for children who participate in learning prior to receiving therapy is 11.25 and 10.60, respectively. The post-test showed a shift in average from the pretest, where the average post-test score was 33.56, after students received BLM-G therapy. The similar effect occurs when students use BLM-non-G in their lectures; in this case, the average post-test score is significantly higher than the average post-test score on the pretest, which is 30.33. The average post-test between the two investigations differs by 3.23. Students who participated in learning using BLM-G and students who participated in learning using BLM-non-G both exhibited an improving average value for their capacity for mathematical and creative thought. The average score for students that participate in BLM-G learning is 0.2496.

Meanwhile, students who took part in learning using BLM-non-G obtained an average score of 0.2194. Judging from the average increase, students taking lessons using BLM-G are higher than those using BLM-non-G. At the middle school level, the difference in the average value of enhancing the capacity for original thought is 0.0302. The two studies' data are distributed in various ways.

The Effect of the GeoGebra Assisted Blended Learning Model (BLM-G) on Creative Thinking Ability

The degree to which BLM-G learning affects students' capacity for both creative and mathematical thought throughout all grade levels, including middle and high school, will be examined in this section. The difference data (difference between the post-test and pretest) in Table 4 are described below:

Table 4. Data Difference Description Summary by Level

Based on High School Level			
		n	Statistic
Difference	Mean Std. Deviation	63	25,23 13,832
Considering Middle School Level			
Difference	Mean Std. Deviation	62	22,31 12,89
Based on the difference in N-Gain between middle and high school levels			
Mid-School Level N-Gain	Mean Std. Deviation	62	0,2496 0,1414
High School Level N-Gain	Mean Std. Deviation	63	0,2865 0,15561

We can test the impact of BLM-G learning for each category, whether large, medium, or small, by paying close attention to Table 4 above. The formula for Cohen's (d) test is used. A t-test was employed for this test. According to the test results, learning BLM-G has a significant impact on one's capacity for original mathematical thought. The computations' outcomes are shown in Table 5 below;

Table 5. Results of the Cohen's(d) Effect Sizes Test in Brief

School Level	Effect Size	Criteria
Tall	1,824	Very High
Currently	17,307	Very High
Gaining Points Between Middle and High School	0,2466	Small

Taking into account Table 5 above, learning utilizing BLM-G can affect, as observed at the high school and middle school levels, and develop the capacity for creative and mathematical thought. It is claimed to have an impact, and based on computations using Cohen's (d) formula and comparisons to the effect size requirements, it may be inferred that learning using BLM-G has a very high category impact on learners' capacity for both mathematical and creative thought. The impact of BLM-G learning on developing mathematical critical thinking is also negligible.

Enhancing Mathematics Creative Thinking Capability from a Learning and School Level

Each level's research hypothesis is presented in this section, and they are as follows:

1. When compared to students who studied with BLMnon-G, students who studied with BLM-G showed a greater improvement in their mathematics creative thinking abilities.
2. Students who study using BLM-G and students who learn using BLMnon-G exhibit different increases in their capacity for mathematical creativity in the middle school category.

It is well known that the first stage is to assess the normality of the data and the homogeneity of variance before the two distinct tests on an average growth in mathematics creative thinking skills based on learning and school level are conducted; Table 6 in the section below provides the summary;

Table 6. Summary of the Data Normality Test for Improving Thinking Ability Based on Learning and Grade Level, Mathematical Creativity

School Level	**Learning**	**Statistical Test**			**Conclusion**
		n	**S-W**	**Sig.**	
Tall	BLM-G	31	0,841	0,000	Reject H_0
	BLM-non-G	32	0,928	0,000	Reject H_0
Currently	BLM-G	32	0,914	0,00	Reject H_0
	BLM-non-G	30	0,911	0,00	Reject H_0

The data on increasing the capacity to think creatively about mathematics based on learning at each school level, namely the high school level and the middle school level, are not normally distributed, as can be seen by paying close attention to Table 6. This table presents data on improving mathematical creative thinking skills in both learning groups and school levels. The non-parametric test was employed in the statistical analysis to compare the two average increases in students' mathematics creative thinking abilities.

Finding the statistical hypothesis is the next step. To compare the growth of students' mathematical creative thinking abilities between high and middle school levels, a statistical hypothesis was put out. The statistical hypothesis is as follows:

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$

Information:

μ_1: *The typical grade for high school pupils taking part in BLM-G learning.*

μ_2: *The typical grade received by high school pupils who took BLM-non-G courses*.

The following statistical hypothesis was put forth to determine whether pupils' growth in mathematics creative thinking skills at the middle school level differed:

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$

Information:

μ_1: *Ratio of women who participated in BLM-G instruction at the current grade level.*

μ_2: *Middle schoolers make up the majority of those who participate in BLM non-G learning.*

Table 7 provides a summary of the findings from the test of the hypothesis that learning and academic level will increase mathematical creative thinking abilities.

Table 7. An overview of the Mann-Whitney Test for Developing Creative Thinking in Mathematics Based on Learning and School Category

School Category	**Statistic test**		
		N-Gain	**Post-test**
Tall	Mann-Whitney U	328	332
	Asymp. Sig. (2-tailed)	0,021	0,024
	n	63	63
Currently	Mann-Whitney U	375,5	364,5
	Asymp. Sig. (2-tailed)	0,141	0,103
	n	62	62

Table 7 shows that the high school level sig. (2-tailed) value is less than 0.05. The null hypothesis is disregarded using the Mann-Whitney test if the sig. (2-tailed) value is less than 0.05. It can be inferred from the table above that the null hypothesis is rejected. Conclusion: Students who study using BLM-G learning have improved mathematics and creative thinking abilities that are superior to those of students who learn using BLM-non-G learning.

Returning to Table 7, we can see that the value of sig. (2-tailed) at the middle school level is greater than 0.05. If the sig. (2-tailed) value is less than 0.05, the null hypothesis is rejected, same like in the Mann-Whitney test decision-making guidelines. On the other hand, it might be said that the null hypothesis is accepted at the middle school level. Conclusion: At the middle school level, students who learn using BLM-G learning and students who study using BLM non-G learning have equal gains in their capacity for mathematical and creative thought.

Discussion

The learning process applied to the experimental class includes two main parts: implementing teaching materials and a learning approach based on the planned pedagogical framework. The teaching materials developed are designed in such a way as to enable students to have the opportunity to create concepts, procedures, and principles in mathematics through a variety of learning activities, including activities that are individual, group, or in pairs, to class activities. Each developed training begins with presenting a problem that serves as an initial stimulus to encourage mental activity in students (Noris et al., 2022).

Based on the learning theory, which is the primary basis for developing the learning model in this study, it is clear that the stimulus factor plays a vital role in a series of mental activities in the form of action-process-object-scheme. In learning mathematics that is carried out through an indirect approach or a combined approach, this is described in the form of mathematical problems which contain challenges for the occurrence of thinking processes which include linking between mental objects that students already have so that new mental things are formed (AlManafi et al., 2023; Rahayu & Putri, 2021), as with Vygotsky's learning theory (Seon-Mi & Kellogg, 2022) with the principle that students must be actively involved. In learning mathematics, the student's activity is more mental. However, in the process, mental activity can be expressed in observable forms both orally and in writing. Thus, the interaction pattern in the learning process is developed so that each student can describe their mental activity, allowing interaction between members of the class community. Interaction forms include group discussions, class discussions, questions and answers, and submission of arguments or explanations (Smolucha & Smolucha, 2021). Activities like this are beneficial in the learning process. When students can carry out certain mental activities and reach a stage of understanding, they can reflect on what they have achieved. They will likely get a new stimulus that allows further mental movement.

The results of the quantitative analysis of this study can strengthen the explanation presented above that the variety of abilities of students who come from schools with different levels is not a significant obstacle to growth and development to improve the ability to think creatively mathematically. Even though the level of activity is very relative to the starting point of students' abilities, the learning model factors that are developed are sufficient to give extreme confidence, where the learning model is very effective in influencing the process of developing students' mathematical creative thinking abilities (Gunawan et al., 2022). The theory of schema development includes a series of formations of new mental objects. The challenges posed by the teacher in the form of problem presentations, questions, or hints can be a very effective stimulus for forming new mental things, which are a strong foundation for creating a cognitive structure called a schema. According to Skemp (1971), the scheme has two functions: integrating existing knowledge and as a mental tool for acquiring new knowledge (Kurniasih et al., 2022).

The effectiveness of learning models that are indirect both regarding the presentation of teaching materials, teacher intervention models, and class interaction models that are developed, can complement the results of other studies that are in line, for example, from Samura and Darhim (2023), and Wahyudi et al., (2021). In the results of Samura and Darhim's research on improving mathematical critical thinking skills using the GeoGebra-assisted blended learning model. The results showed that using the GeoGebra-assisted combined learning model increases mathematical necessary thinking skills in junior high school students in Ternate, Indonesia. In addition, students who learn using the blended learning model assisted by GeoGebra are better than students who learn using the blended learning model without the assistance of GeoGebra. Likewise, the research conducted by Wahyudi et. al on schemata and the ability to think creatively in cool-critical-creative meaningful (3CM) learning. The result is that the learning model using 3CM is very effective, significantly improving students' mathematical creative thinking abilities.

To encourage students' mathematical thinking processes, teachers, among other things, carry out probing techniques with the aim that students can provide a more detailed explanation of the results of a thought process that is carried out. Students are encouraged to find alternative solutions to a given problem to develop alternative thinking skills. Furthermore, for students to have a more comprehensive understanding of their problems, an analysis and comparison of the alternative solutions found by students is then carried out (Kontrová et al., 2021). To increase the ability to think creatively through encouragement to come up with alternative solutions and discuss them in class discussions, in an indirect approach developed, this is an integral part of a more general overall strategy. The main focus of the indirect method is the teacher intervention model, which is more indirect (Huincahue et al., 2021). Thus, it does not matter whether the questions posed to students are open-ended or not.

Conclusion

During the middle and high school years, BLM-G learning has a very high category impact on students' mathematics creative thinking and thinking abilities. Based on the high school level, pupils who learn using BLM-G learning improve their capacity for both mathematical and creative thought more than those who learn using BLM-non-G learning. At the middle school level, there is no difference in the development of students' capacities for both quantitative and creative cognition between students who study using BLM-G learning and students who study using BLM-non-G learning.

Recommendations

This study applies a blended learning model to measure students' mathematical creative thinking skills assisted by GeoGebra in junior high schools in Ternate City, Indonesia. The results found that the blended learning model assisted by GeoGebra can influence students' ability to improve students mathematical creative thinking skills. Therefore, researchers can recommend mathematics teachers who teach in junior high schools to be able to apply various kinds of learning models in the class. With the aim that in the implementation of learning later, students can be active in solving problems encountered in the learning process. As in the blended learning model assisted by GeoGebra, students are automatically involved in solving problems given by the teacher or problems they create themselves. In solving problems, students are always assisted by GeoGebra to determine the final solution from the set of keys to a problem. Therefore, in the learning process in the classroom, mathematics teachers should always apply learning models, one of which is the blended learning model assisted by GeoGebra.

Limitations

The weakness of this study is that the research subjects were only taken from two junior high schools from the number of schools in Ternate City, Indonesia. Therefore, it is necessary to conduct further research to examine if the subject matter in mathematics is taken, not just straight-line equations. In addition, in the learning process, there are still obstacles to providing computers in schools/research locations. From these results, it is suggested that each school needs to prepare more computers so that when students practice using the computer, they don't queue to use it. It is recommended that other researchers develop research related to students' mathematical creative thinking abilities by applying learning models or approaches related to learning mathematics.

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Authorship Contribution Statement

Samura: Conceptualizing, designing, collecting data, and analyzing data. Habsyi: Designing, collecting data, and analyzing data.

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