Improving Mathematics Critical Thinking Skills of Junior High School Students Using Blended Learning Model (BLM) in GeoGebra Assisted Mathematics Learning

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Abstract—This study examines and analyzes the improvement of students' mathematical critical thinking skills who learn using the blended learning model assisted by GeoGebra and students who learn using the blended learning model without the assistance of GeoGebra, seen from the learning and school level. The type of research used is quasi-experimental, using a nonequivalent control-group design. Participants totaled 125 students from class VIII at Middle School in Ternate City, Indonesia. The instrument used is a matter of critical thinking ability test. The study results show that the blended learning model assisted by GeoGebra influences the ability to think critically mathematically in a vast category. At the high school level, the increase in mathematical critical thinking skills among students who studied using the blended learning model assisted by GeoGebra was better than students who learned using the blended learning model without the assistance of GeoGebra, with the improvement in the low category. Middle school level, there is no difference in the improvement of mathematical critical thinking skills between students who learn using the blended learning model assisted by GeoGebra and students who learn using the blended learning model without GeoGebra assistance.

Keywords—Mathematical critical thinking ability, blended learning model, applied GeoGebra

1 Introduction

Critical Thinking is part of reflective Thinking that can shape one's attitude to believe in others. According to [1][2], Critical Thinking is the ability to analyze, synthesize, and evaluate. Critical thinking skills can develop when stimulated by learning mathematics. Learning mathematics is the most source problem that can hone critical thinking skills. Based on the theory, critical thinking indicators were developed to analyze and evaluate arguments and evidence, clarify, make judgments, make explanations, and identify assumptions. Critical thinking indicators provide many ideas, reveal new ways, develop ideas and produce alternative answers [3][4][5].

[6] Critical Thinking is an important component that every student must have because, along with the rapid development of technology and the economy, every time a person is required to think critically, not only to accept information for granted but must be able to sort things out. -Choose the information it receives and look for cause and effect and the evidence logically and rationally. Therefore, instilling the habit of mathematical critical Thinking needs to be done so that students can overcome various problems and problems that occur in everyday life [7][8][9].

Improving mathematical critical thinking skills in problem-solving requires a model or learning approach that involves more students actively in the learning process. Everything can be realized through a form of learning that is designed in such a way that it can reflect the active involvement of students in instilling cognitive awareness [10][11]. The blended learning model (BLM) is a learning model that can be used to help students improve their mathematical critical thinking skills. BLM is a combination of two learning models/approaches. BLM can be done by combining several models or learning approaches to achieve the learning process's objectives. The combination of models used is the primary key to BLM [12][13].

The types of BLM used in this study are Outside-In blended learning and lab rotation blended learning. The Outside-In Blended Learning model is learning that starts from a non-academic physical and digital environment and then ends in the classroom. Where learning in the classroom will be more in-depth. Face-to-face classes have the opportunity to share, be creative, collaborate, and give each other feedback that can improve the quality of student learning. The lab rotation blended learning model is learning that combines each meeting that can be divided into several parts and requires a computer laboratory [14].

The BLM used in learning is a combination of Outside-In blended learning and lab rotation blended learning using the Realistic Mathematics Education (RME) approach and the Student's Learning Experience, where both types will support the learning process in the classroom using RME. The application of RME in the classroom needs to be equipped with students' learning experiences, and it will have difficulty increasing mathematical critical thinking skills. Tyler said [15] that the learning experience involves the interaction of the learner and his environment so that some features of the environment in which he is located can attract his attention, and to him, he reacts. Implicit in the definition of this learning experience is that the learner actively participates in the learning process.

The application of these two models was carried out in two schools at different levels. School leveling is determined based on school accreditation scores and the highest average score on national exam results in mathematics. For the high school level, the school's accreditation score must be an A, the national exam average score for the subject must be higher than other schools, or the math score must be above the passing standard. Likewise, at the medium school level, the school accreditation score is an A, and the average score of the national exam results cannot be less than the passing standard but may be the same as the passing standard.

GeoGebra is software that can be used in mathematics learning; it continues to be in great demand by mathematics researchers and educators, and its the potential to revolutionize mathematics teaching and learning. The use of GeoGebra in teaching and learning mathematics allows students to be able to describe geometric objects quickly and specifically. GeoGebra features Dynamic Geometry Software, a Computer Algebra System, and a paper sheet. All in one integrated package. The GeoGebra application can provide a virtual environment for students to simultaneously view the numerical algebraic components (e.g., equations or coordinates) and the corresponding geometric features of an object. Finding new patterns, exploring and testing conjectures, and manipulating various geometric shapes, are among the many activities students can do by designing and drawing their sketches on dynamic mathematical software applications [16][17].

[18] The results of his research explain that students' mathematical critical thinking skills using Concept Attention Model (CAM) learning are better than those using Conventional Learning (CL) based on students' initial mathematical abilities. The same thing was done by [19] that (1) the Mathematics learning model is effective in stimulating critical Thinking, meaning that the application of the mathematics learning model is practical to stimulate critical Thinking; (2) data analysis of eleven stages of problem-solving proves that the criteria for critical thinking skills are categorized as good and very good. The highest scoring indicators consider the principles and definitions of transformation, while the lowest scoring indicators mainly relate to questions on correct and coherent measures; (3) critical thinking skills have seven indicators that highlight the criteria for students' critical thinking abilities, which are categorized as good and very good. The indicator with the highest score determines the definition of the term, while the indicator with the lowest score determines the action; (4) the results of the analysis show indicators of mathematical critical thinking skills, which have eight indicators. The criteria for students' critical thinking skills meet the good and excellent categories, with indicators with the highest score considering the definition of terms. In contrast, the lowest score indicator is a habit of caution.

Various explanations have been put forward, so the researcher can formulate the research problem as follows:

1. Can learning with BLM-G influence critical thinking skills in junior high school students?
2. Is there a difference in increasing mathematical critical thinking skills between students who learn to use BLM-G and students who learn to use BLM non-G in terms of a) overall; and b) school level?

Based on the background description stated above, the author, at this moment, assumes that a comprehensive, in-depth study of mathematical critical thinking skills using GeoGebra-assisted BLM is needed. For this reason, the authors conducted research entitled "Improving Mathematical Critical Thinking Skills for Junior High School Students Using BLM in GeoGebra Assisted Mathematics Learning" to obtain a comprehensive study.

2 Mathematical critical thinking ability

Critical thinking is an active intellectual discipline process and proficiency in conceptualizing, applying, synthesizing, and evaluating information from the results of collection or generated from observation, experience, reflection, reasoning, or communication as a reliable guide in acting. Chaffe [20] defines critical thinking as thinking to investigate the thinking process itself systematically. Meaning that it is not only thinking deliberately but also examining how we and others use evidence and logic. For daily life, what is needed in critical thinking is that there is a problem, defines a clear problem, and overcoming the problem "can be solved not in one way but in many ways to get the right solution" [21].

Mathematical critical thinking is the power of thinking that all students must build or possess to form a good personality and solve their life problems [22]. The ability to think critically is essential for everyone, especially students, because this ability can help students behave rationally and make the best choices for themselves. Students who think critically will quickly face their problems and determine the best for themselves. Likewise, students with good critical thinking skills will have good character and personality implemented in all aspects of life. Students' mathematical critical thinking skills must be empowered, which is integrated through methods, models, and or approaches in learning [23].

Six essential elements in critical thinking are abbreviated as FRISCO (Focus, Reason, Inference, Situation, Clarity, Overview). The explanation of FRISCO is as follows: 1) Focus (focus), meaning to focus on making decisions from existing problems. 2) Reason, providing rational reasons for the decisions taken. 3) Inference (conclusion), making conclusions based on convincing evidence by identifying various arguments or assumptions and looking for alternative solutions while still considering the situation and existing evidence. 4) Situation, understanding the key to the problem that causes a situation or situation. 5) Clarity, explaining the meaning of the terms used. 6) Overview (check back), conduct a thorough re-examination to find out the accuracy of the decisions that have been taken [24].

Beyer [25] describes the characteristics associated with critical thinking as follows:

a) Character (dispositions)

Someone with critical thinking skills is likely to have a skeptical attitude, be very open, appreciate honesty, respect various data and opinions, respect clarity and thoroughness, look for different views, and change attitudes when there is an opinion that he considers suitable.

b) Criteria

Critical thinking must have a criterion or benchmark. Someone have to find something to decide or believe in to get in that direction. Although an argument can be compiled from several sources of learning, it will have different criteria. If we apply standardization, it must be based on relevance, the accuracy of facts, credible sources, thorough, unbiased, free from erroneous logic, consistent logic, and careful consideration.

c) Consideration or thought (reasoning)

This ability is to summarize conclusions from one or several premises. The process will include testing the relationship between several statements or data.

d) Point of view

A point of view is a way of looking at or interpreting this world, which will determine the construction of meaning. Someone who thinks critically will look at a phenomenon from various perspectives.

e) Procedure for applying criteria

The procedure for applying critical thinking is very complex and procedural. The procedure will include formulating the problem, determining the decisions, and identifying estimates.

3 Blended Learning Model

Blended Learning Model (BLM) is a learning model that combines several learning models in one unit in the computer-assisted classroom learning process (offline or online). Thus, BLM implies a learning model that combines learning between one learning model with other computer-aided learning models [26]. BLM can be used to describe a solution that combines several different delivery models. BLM also describes learning that combines various event-based activities, including face-to-face classes and self-directed learning [27][28].

BLM learning can be categorized into three, namely;

1. Skills-based learning combines independent learning with the support of an instructor or facilitator to develop specific knowledge and skills.
2. Attitude-driven learning combines various events and delivery media to develop specific behaviors.
3. Competency-based learning combines performance support tools with knowledge management resources and mentoring to develop competencies in the workplace.

The BLM learning model can be applied using the Realistic Mathematical Education (RME) learning approach and student learning experiences in mathematics education with the help of GeoGebra. Along with the development of science in the 21st-century era, namely the development of today's digital technology era, information and communication technology is a medium that can transfer knowledge. Computers are media that can combine abstract mathematical ideas with concrete mathematical ideas [29]. Computers can also be used as a strategy in classroom learning. There is so much software on the computer; this software can help the learning process, especially in learning mathematics. GeoGebra is good software using a computer that can be applied to learning mathematics.

Computer programs can also be said as an effective alternative solution. One of the computer programs that can be used freely is GeoGebra. GeoGebra is a software used by mathematics educators (teachers and lecturers) in Indonesia. GeoGebra can also be said as open-source software that anyone can download at http://www.GeoGebra.com for free. GeoGebra is a Multilanguage and is available in a choice of Indonesian or foreign languages [30].

4 Realistic mathematics education

Realistic Mathematics Education (RME) is a learning approach first applied by the Freudenthal Institute, Utrecht University in the Netherlands in the 1970s. The RME approach can be applied to mathematics education's teaching and learning process. Over the years, RME has been developed and tested in the Netherlands and has proven to be successful in stimulating students' reasoning and thinking activities. This approach refers to the Freudenthal opinion [9][31], which says that mathematics must be related to reality and that mathematics is a human activity. This means that mathematics must be close to the child and relevant to everyday life. This approach is based on the assumption that Hans Freudenthal (1905-1990) said that mathematics is a human activity "mathematics is a human activity." According to this approach, the mathematics classroom is not a place to transfer mathematics from the teacher to students but a place where students rediscover mathematical ideas and concepts through exploring real problems. According to Hans Freudenthal, mathematics is " a human activity" that stems from problem-solving. Here, students can be seen as not passive recipients but can rediscover mathematical ideas and concepts through teacher guidance [32].

Gravemeijer [32] explains that mathematics as a human activity means that humans must be given the freedom or opportunity to rediscover mathematical ideas and concepts with the guidance of adults who know what mathematics is. This effort is carried out through an orientation activity on various situations in real/realistic problems. Slettenhaar [33] Realistic, in this case, does not refer to reality but to something that students can imagine. In essence, the principle of rediscovery can be realized in informal solving procedures, while the process of rediscovery uses the concept of mathematization.

Freudenthal [33] explains that the RME has five principles, namely: 1) Dominated by problems in context, serving two things, namely as a source and as an application of mathematical concepts; 2) Attention is paid to developing models, situations, schemas, and symbols; 3) Contributions from students, so that students can make learning constructive and productive, meaning that students produce and construct themselves (which may be in the form of algorithms, rules, or rules). So that it can guide students from the level of informal mathematics to formal mathematics; 4) Interactivity as a characteristic of the mathematics learning process, and 5) Intertwining (making links) between topics or subjects.

5 Research method

5.1 Research design

Quantitative research is an accessible experiment applying BLM-G learning using a nonequivalent control-group design. Taking subjects in experimental and control classes is not done randomly because, in practice, the subject is already in a particular class [34]. Each class was given a pretest from a mathematical critical thinking ability test (O). After the implementation of learning is complete, each class is given a posttest using the same questions as the pretest. The goal is to give a pretest and posttest to determine the occurrence of an increase in the critical mathematical thinking ability to be measured. The class given learning using BLM-G is referred to as the experimental class (X). In contrast, the class that is given learning using the blended learning model without the aid of GeoGebra is referred to as the control group [35]. The nonequivalent control-group research design can be seen in Figure 1 as follows.

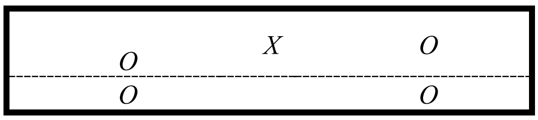

Fig. 1. Nonequivalent control-group design

Information
O; Pretest and Posttest
X; GeoGebra-assisted Blended Learning Model.
Comprehensively, this study examines and analyzes the influence of learning factors on increasing mathematical critical thinking skills involving school-level factors. Learning factors using BLM-G and learning using BLM non-G. Mathematical critical thinking ability is the dependent variable. School-level factors consist of high school and middle school levels called control variables.

5.2 Participants

Participants were taken from two schools with different levels. School leveling is based on the National Examination (NE) results and school Accreditation scores. The average score of the National Examination in mathematics and the value of higher school accreditation is used as a high school level, and vice versa can be used as a medium school level. The number of participants at the high school level was 63, and the number at the middle school level was 62. The total number of participants was 125 people. The two schools took two classes each. The details are as follows; one class is used as an experimental class, and one is a control class.

5.3 Research instruments

This study uses an instrumnt in the form of a test. The test instrument consists of questions related to mathematical critical thinking skills. The arranged critical thinking ability test is a description question that pays attention to the indicators in the mathematical critical thinking ability. This study's mathematical critical thinking ability test includes the material of straight-line equations. There are five questions in the form of a description with a processing time of 2 × 45 minutes. Implementation of the test after the entire learning process ends. Before using, the mathematical critical thinking ability test questions were validated to see the content and face validity and then tested empirically.

Development of learning tools with BLM-G and paying attention to aspects of mathematical critical thinking skills by considering the school curriculum as a guide for implementing learning. The research developed learning tools, Learning Implementation Plans (RPP), and Student Activity Sheets (LAS).

5.4 Research stages

This research has two stages, namely the preparation stage and the implementation stage, which can be explained as follows:

1. Preparation

Once the problem is formulated, developing research instruments and learning tools is next. The research instruments and learning tools were then validated. Then a limited trial was carried out with several students at each school level to determine the level of language readability and, at the same time to get an idea of whether the instruments used could be understood well by students. After the test results are obtained, an analysis is carried out to obtain a good description of the instruments and devices for further use during the study.

2. Implementation

The research was conducted at two schools after obtaining permission from the relevant parties. The researcher observed the two schools that were used as research sites. During the observation, through discussions and considerations made by the mathematics teacher and the school, the experimental grid control groups were determined as participants in the study.

5.5 Data analysis technique

The data analyzed in the form of mathematical critical thinking ability test results were then analyzed quantitatively using several statistical tests. Before determining the statistical test, the normality and homogeneity of variance tests were first performed. More details will be presented on the steps in the data processing. Once all the data is collected, the next step is calculating it. The calculations carried out in this study are as follows:

a) Calculate descriptive statistics of pretest, posttest, and Gain scores, including the minimum, maximum, mean, and standard deviation values. Descriptive statistical analysis only provides an overview of the sample without drawing conclusions that apply to the population.
b) The researcher calculates the increase in students' mathematical critical thinking skills using the normalized gain developed by [36]. Normalized gain is obtained by comparing the Difference between the pretest score and the posttest score with the Difference between the ideal maximum score and the pretest score, which can be written as follows.

$$Normalized\ gain\ (NG) = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal max score} - \text{pretest score}} \quad (1)$$

Gain value index criteria can be seen in Table 1:

Table 1. Normalized gain score criteria

Normalized Gain Score (NG)	Interpretation
$g \geq 0{,}70$	Height
$0{,}30 \leq g < 0{,}70$	Medium
$g < 0{,}30$	Low

c) Calculate the magnitude of the effect of BLM-G learning on students' critical thinking and mathematical creative thinking skills using the effect sizes developed by Cohen (1988). The formula used is as follows:

For paired sample t-test

$$Cohen's d = \frac{\bar{d}}{s_d} \quad (2)$$

Information:
$\bar{d}$: mean divergence (Difference)
s_d : Standard deviation of mean divergence
For unpaired sample t-test

$$Cohen's\ d = \frac{\overline{X_B} - \overline{X_A}}{Pooled\ SD} \quad (3)$$

For the same number of samples, the pooled sd formula can be used as follows;

$$Pooled\ sd = \sqrt{\frac{(S_A)^2 + (S_B)^2}{2}} \quad (4)$$

For the number of samples that are not the same, the pooled SD formula can be used as follows;

$$Pooled\ sd = \sqrt{\frac{(n_A - 1)X(S_A)^2 + (n_B - 1)X(S_B)^2}{n_A + n_B - 2}} \quad (5)$$

To translate the value of d, Cohen's effect size classification is used [37], as shown in Table 2.

Table 2. Classification of Cohen's effect size

Effect Size	Criteria
$0,00 \leq ES < 0,20$	Very small
$0,20 \leq ES < 0,50$	Little
$0,50 \leq ES < 0,80$	Medium
$0,80 \leq ES < 1,30$	Height
$1,30 \leq ES$	Very Big

Here, quantitative data is analyzed using inferential statistical analysis. Stages of inferential statistical analysis can be used in several tests that correspond to the characteristics of the data (customarily distributed, homogeneous). This stage is carried out to test the hypothesis proposed in the study. The following are the steps carried out in inferential statistical analysis, among others:

1. Prerequisite test of parametric statistics on data on increasing mathematical critical thinking skills. The data are grouped based on learning (learning with BLM-G and learning with BLMnon-G) and school level (high and medium).
2. The hypothesis tests include the t-test, Mann-Whitney, two-way ANOVA, and Cohen's.
3. If data is not generally distributed in the test, then the data analysis is carried out using nonparametric statistical tests.

6 Findings and discussion

The results of this research are quantitative data derived from the mathematical critical thinking ability test. These data are grouped into several categories, data on mathematical critical thinking skills at the high and middle school levels.

6.1 The effect of BLM-G on mathematical critical thinking ability

In the following, a test will be conducted on how much influence BLM-G learning has on mathematical critical thinking skills seen from the overall, highland middle school level data description of Difference (Difference between posttest and pretest) is presented in Table 3.

Table 3. Description of data difference based on overall, high school level and middle school level

Based on Overall			
		n	***Statistic***
Difference	Mean	125	19,3492
	Std. Deviation		9,75367
By High School Level			
Difference	Mean	63	21,9355
	Std. Deviation		9,59839
Based on Medium School Level			
Difference (Perbedaan)	Mean	62	16,8438
	Std. Deviation		9,37777
Based on N-Gain between Middle and High School Level			
N-Gain Middle School Level	Mean	62	0,1954
	Std. Deviation		0,09265
High School Level N-Gain	Mean	63	0,267
	Std. Deviation		0,10589

Table 3 can be tested on the effect of BLM-G learning, whether in the large, medium or small categories. Testing using Cohen's formula (d). In this test, the t-test is used. The test results found that the effect of BLM-G learning on mathematical critical thinking skills was in large categories. Following are the results of the calculations in Table 4.

Table 4. Cohen's effect sizes. test results

School Level	Effect Size	Category
Overall	1,9837	Very Big
Tall	2,2853	Very Big
Currently	1,7961	Very Big
Value Gain between Middle and High School Level	0,7233	Currently

In Table 4, it can be explained that learning using BLM-G can affect mathematical critical thinking skills, viewed from the overall high school level and middle school level, and increase mathematical critical thinking skills. It is said to influence because the calculation results used Cohen's formula (d), and compared with the criteria of effect sizes, it can be concluded that the effect of learning using BLM-G on mathematical critical thinking skills is very high. Likewise, in increasing mathematical critical thinking skills, the effect of BLM-G learning is in the medium category.

6.2 Improving mathematical critical thinking ability based on learning and school level

The research hypothesis proposed in this section is the hypothesis of each school level, including:

1. At the high school level, improving mathematical critical thinking skills among students who take BLM-G learning is better than students who take BLM non-G lessons.
2. At the middle school level, there are differences in the improvement of mathematical critical thinking skills between students who take BLM-G learning and students who take BLM non-G lessons.

It is known that before testing the Difference between two averages of increasing students' mathematical critical thinking skills based on learning and school level, the first step is to test the normality and homogeneity of variance. The results of the normality test can be seen in Table 5.

Table 5. Summary of normality test of ability improvement data mathematical critical thinking by school level

School Level	Learning	Shapiro-Wilk			Conclusion
		Statistic	*df*	*Sig.*	
Height	BLM-G	0,960	31	0,292	Accept H_0
	BLMnon-G	0,987	32	0,965	
Medium	BLM-G	0,515	31	0,000	Accept H_0
	BLMnon-G	0,950	30	0,168	

Table 5 explains that the value of Sig. from the two school levels looks different. The data are typically distributed at the high school level and are not generally distributed at the medium school level. For data at the high school level, homogeneity tests can be carried out, while at the medium school level, there is no need to test for homogeneity. Nonparametric tests can test the differences between the two learning groups for data that are not normally distributed.

Table 5 shows that the data at the high school level is usually distributed; it can be tested for homogeneity of variance using Levene's test, as shown in Table 6.

Table 6. Results of homogeneity of variance of data on ability improvement of mathematical critical thinking based on learning and high school level

School Level	Learning	Levene Statistic	df1	df2	Sig.	Conclusion
Height	BLM-G	0,011	1,000	61	0,9157	Accept H_0
	BLMnon-G					

Table 6 explains the value of Sig. Those who are at the high school level have the value of Sig. More than the value of = 0.05. This means that the data on increasing students' mathematical critical thinking skills in the two learning classes has a homogeneous variance. Next is to test the difference between the two averages.

The statistical hypothesis proposed to see the difference in the improvement of students' mathematical critical thinking skills at the high school level:

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 > \mu_2$

Information:

μ_1 : The average value of mathematical critical thinking skills at the high school level of students taking BLM-G learning

μ_1 : The average value of mathematical critical thinking skills at the high school level of students taking non-G BLM learning

The statistical hypothesis proposed to see the difference in the improvement of students' mathematical critical thinking skills at the middle school level:

H_0: $\mu_1 = \mu_2$

H_1: $\mu_1 \neq \mu_2$

Information:

μ_1: The average value of mathematical critical thinking skills at the middle school level of students who take BLM-G learning

μ_2: The average value of mathematical critical thinking skills at the medium school level of students who take part in non-G BLM learning

Noting that the data at the high school level has a homogeneous variance, the statistical test of the hypothesis above is used as a parametric statistical test using a t-test. This test aims to see the difference between the average increases in critical thinking skills with homogeneous variances. The criterion for testing the hypothesis is that the null hypothesis is accepted if the value of tcount is less than ttable or Sig. (2-tailed) is more than $\alpha = 0.05$.

Likewise, data at the middle school level does not have normally distributed data, so testing on data like this can be done using nonparametric statistical tests using the Mann-Whitney test. The test criteria in the Mann-Whitney test reject the null hypothesis if the significance value (Sig.) is less than 0.05, and other things are rejected. The completeness of statistical test results on the two proposed hypotheses can be explained in the independent sample t-test table and the Mann-Whitney test. Both tests were carried out because the data in the two samples had different distributions. To clarify, a summary of the results of the hypothesis testing above is provided in Table 7.

Table 7. T-test and Mann-Whitney differences in mathematical critical thinking ability improvement based on learning and school level

School Level	Statistics Test					Conclusion
	Mann-Whitney	***Asymp.Sig (2-tailed)***	***df***	***t***	***Sig. (2-tailed)***	
Height	[redacted]		62	2,393	0,02	Reject H_0
Currently	411,5	0,91	62	[redacted]		Accept H_0

Table 7 explains the value of Sig at the high school level. (2-tailed) is less than = 0.05, while $t_{count} = 2.393$. For df = 62, the value of $t_{table} = 2,000$ is obtained. Based on the decision-making basis for the t-test, rejecting the null hypothesis if the value of Sig. Less than 0.05. Thus, at the high school level, it can be concluded that improving mathematical critical thinking skills among students who learn to use BLM-G learning is better than students who learn to use non-G BLM learning. Likewise, at the middle school level, the Mann-Whitney test results show the value of Sig. (2-tailed) is greater than = 0.05. Based on the decision-making rules for the Mann-Whitney test, it can be concluded that there is no difference in increasing mathematical critical thinking skills between students who learn to use BLM-G learning and students who learn to use non-G BLM learning.

7 Conclusion

The blended learning model assisted by GeoGebra influences mathematical critical thinking skills with a vast category. At the high school level, the increase in mathematical critical thinking skills among students who studied using the blended learning model assisted by GeoGebra was better than students who learned using the blended learning model without the assistance of GeoGebra, with the increase in the low category. Middle school level, there is no difference in the improvement of mathematical critical thinking skills between students who learn using the blended learning model assisted by GeoGebra and students who learn using the blended learning model without GeoGebra assistance.

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