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1.Bukti Konfirmasi Submit Artikel dan Artikel yang Disubmit (31 Mei 2022)



Fitri Alyani <fitrialyani@uhamka.ac.id>

[JPP] Submission Acknowledgement

2 messages

Dr. IG.A. Lokita Purnamika Utami, S.Pd., M.Pd <ejournal@undiksha.ac.id>
To: Fitri Alyani <fitrialyani@uhamka.ac.id>

Tue, May 31, 2022 at 10:35 AM

Fitri Alyani:

Thank you for submitting the manuscript, "The Effect of Learning Using Geogebra Software on Mathematical Critical Thinking Ability Based on Adversity Quotient" to Jurnal Pendidikan dan Pengajaran. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

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Dr. IG.A. Lokita Purnamika Utami, S.Pd., M.Pd

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Fitri Alyani <fitrialyani@uhamka.ac.id>
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Tue, May 31, 2022 at 10:42 AM

----- Forwarded message -----

From: **Dr. IG.A. Lokita Purnamika Utami, S.Pd., M.Pd** <ejournal@undiksha.ac.id>
Date: Tue, 31 May 2022, 10:35
Subject: [JPP] Submission Acknowledgement
To: Fitri Alyani <fitrialyani@uhamka.ac.id>

Fitri Alyani:

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2. Bukti Konfirmasi Review dan Hasil Review Pertama (5 Juli 2022)



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[JPP] Editor Decision

1 message

Ejournal Undiksha <ejournal@undiksha.ac.id>

Tue, Jul 5, 2022 at 3:24 PM

To: Fitri Alyani <fitrialyani@uhamka.ac.id>, Natalia Sartika <nata.dspr@gmail.com>

Fitri Alyani, Natalia Sartika:

We have reached a decision regarding your submission to Jurnal Pendidikan dan Pengajaran, "The Effect of Learning Using Geogebra Software on Mathematical Critical Thinking Ability Based on Adversity Quotient".

Our decision is to: Revision Required

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2 attachments**A-47491 Natalia+dan+Fitri+Full+Artikel+(Jurnal+Pendidikan+dan+Pengajaran)-Reviewer A.doc**
1401K**B-47491 Natalia+dan+Fitri+Full+Artikel+(Jurnal+Pendidikan+dan+Pengajaran)-Reviewer B.doc**
1402K



The Effect of Learning Using Geogebra Software on Mathematical Critical Thinking Ability Based on Adversity Quotient

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Abstrak

Penelitian ini ialah penelitian kuantitatif eksperimen dengan tujuan mengetahui pengaruh pembelajaran menggunakan *software GeoGebra* terhadap kemampuan berpikir kritis matematis berdasarkan *adversity quotient*. Populasi penelitian ini yaitu siswa SMA kelas XII di Jakarta dan sampel yaitu 40 siswa yang berasal dari kelas eksperimen dan 40 siswa berasal dari kelas kontrol dengan pembelajaran konvensional dan dipilih secara purposive. Instrumen tes didasarkan pada penilaian kemampuan kritis matematis dan non-tes berupa angket *adversity quotient*. Hasil yang diperoleh dari pembelajaran matematika menggunakan *software GeoGebra* memiliki kemampuan berpikir kritis lebih baik dari siswa dengan pembelajaran matematika konvensional. Berdasarkan *Wright Maps*, *adversity quotient* siswa tipe *climber* didominasi oleh siswa dengan pembelajaran menggunakan *GeoGebra*. Sementara tipe *quitter* didominasi oleh siswa dengan pembelajaran konvensional.

Kata kunci: *Adversity Quotient*; Kemampuan Berpikir Kritis Matematis; *Geogebra Software*

Abstract

This research is experimental quantitative research with the aim of knowing the effect of learning mathematics using GeoGebra software on mathematical critical thinking skills based on the adversity quotient. The population of this research is high school students of class XII in Jakarta and the sample is 40 students from the experimental class and 40 students from the control class with conventional learning and selected purposively. The test instrument is based on an assessment of critical mathematical abilities and a non-test in the form of an adversity quotient questionnaire. The results obtained from learning mathematics using GeoGebra software have better critical thinking skills than students with conventional mathematics learning. Based on the Wright Maps adversity quotient climber-type students are dominated by students who study using GeoGebra. While the quitter type is dominated by students with conventional learning.

Keywords: *Adversity Quotient*; *Mathematical Critical Thinking Ability*; *Geogebra Software*

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1. INTRODUCTION

Mathematical critical thinking is the foundation of the thinking process in generating ideas, analysing arguments, and developing a logical mindset (Dhayanti et al., 2018; Wahyu Hidayat & Sari, 2019; Wechsler et al., 2018). The thought process in question is carried out, so that in learning not only remember and know the concept but to the stage of developing a mindset and applying it in a structured manner. For this, Batubara (2019) states that critical thinking is not only able to remember or know the concepts that have been studied but, in the process, can express again with other easy-to-understand concepts, interpret data and apply concepts based on structured logical thinking patterns.

Referring to the content standards contained in primary and secondary education units in mathematics subjects by teachers, among others, there are analytical, logical, creative, systematic, and critical thinking skills, that can work together (Asmar & Delyana, 2020). The re-application of mathematical critical thinking skills in the 2013 curriculum has the aim that, in learning, students will be able to start thinking critically (Wulandari, 2020). Because they need critical thinking skills to overcome their problems in life (Delina et al., 2018). Paul and

Commented [RVA1]: The author's name is written using TNR font size 12 without a title, the first name is abbreviated while the last name (surname) is not abbreviated.

Commented [RVA2]: Email writing is adjusted to the provisions of the email provider

Commented [RVA3]: ABSTRACT:

- 1.*150-250 words
- 2.Start writing the research problem 2 sentences are enough.
- 3.research design (1 sentence is enough)
- 4.Data collection methods and research instruments.
- 5.Analysis of the data used,
- 6.Results in line with goals
- 7.Conclusions, are general in nature and answer research problems.
- 8.The place of research/data collection does not need to be written in the abstract
- 9.If it is still less than 200 words, the implications can be added.

Commented [RVA4]: Keywords consist of 3-5 words or groups of words that are conceptual and reflect the content of the article

Commented [RVA5]: INTRODUCTION:

The introduction is more systematic, there is a connection between paragraphs with one another. Reinforce by adding international indexed references

Elder (2019) developed indicators of critical thinking skills which include the identification process, analysis of the results of identification, then evaluation, and finally the conclusion process. Based on this, critical thinking skills are important for students to have because they can develop a logical mindset, can think rationally, and apply them in dealing with problems in the learning process.

However, the importance of critical thinking skills is not accompanied by an optimal learning approach and one's initial abilities, so it influences studies related to the results of skills in mathematical critical thinking. This is based on the findings (W. Hidayat & Aripin, 2019) which state that the learning approach and initial abilities cannot meet the achievement of mathematical critical thinking skills. Not only initial abilities and approaches to learning mathematics are the determinants of success, but there is also an attitude factor in it. Mathematical critical thinking according to Rahayu and Alyani (2020) is an ability that demands being able to solve all the problems it is facing. To be able to fight through this challenge, the Adversity Quotient plays an important role in solving the problems in it.

Adversity Quotient (AQ) is a concept that was first put forward by Paul Stolz in measuring how hard a person's struggles and ability to solve problems is also one of the attitude factors that influence mathematical critical thinking skills in mathematics subjects (Rahayu & Alyani, 2020). This can be seen in Quitter's difficulty in solving existing problems and is classified as weak in critical thinking achievement, namely at an average score of 4.27 (Sari & Hidayat, 2019). Adversity quotient is divided into three types: Climber, Camper, and Quitter. In this initial type (Climber), whatever pressure a person faces will tend to be able to persist in solving the problems at hand. The second type (Campers) tend to be satisfied with what they get and don't want to take high risks. Then, in the third type (Quitters) a person tends not to want to try to be able to solve the problem, and gives up easily. So that the three types can also be used as indicators of a person facing difficulties (Wahyu Hidayat et al., 2018; Wulandari, 2020). Wahyu Hidayat & Sari (2019) stated that the adversity quotient plays a role in influencing the achievement of mathematical critical thinking skills. This is supported by research that reveals the effect of Adversity Quotient on mathematical critical thinking skills by 75%, especially for the camper type (Rahayu & Alyani, 2020). Through the ability to solve a challenge, one can train one's mathematical critical thinking skills (Supandi & Senam, 2020). So mathematical critical thinking skills are very important because they influence the Adversity Quotient aspect.

There have been several studies in recent years related to the adversity quotient, namely, Rahayu & Alyani (2020), Wahyu Hidayat & Sari (2019), Wahyu Hidayat et al. (2018), Yanti et al. (2018). Rahayu & Alyani (2020) discuss that the largest distribution of AQ type is in the camper type by 69.23%, and 75% of AQ has an influence on mathematical critical thinking ability while the rest comes from external factors. Wahyu Hidayat and Sari (2019) stated that the lowest achievement when solving questions was seen in the quitter type students and the highest in the camper type. Thus, the influence given by AQ on the achievement of critical thinking is good. Wahyu Hidayat et al. (2018) in their research found that AQ had a large effect on the argumentation ability of prospective teachers by 60.2% and other factors 39.8%. Then Yanti et al. (2018) show that climber 1 students can fulfill all wallas indicators with moderate completeness, climber 2 students have difficulty on several indicators so climber 2 students have creative abilities in the medium category.

Developments and changing times require humans to be able to think critically, logically, creatively, take initiative and be adaptive to change (Yanti et al., 2018). This requires rapid technological developments with both positive and negative impacts on life, including in the world of education through learning media. Batubara (2019) stated that mathematical critical thinking skills increased with the help of learning media in the form of GeoGebra software compared to without GeoGebra software. Geogebra is an open-source

mathematical software program that can be accessed by anyone with an internet network. Not only that, this software is easy to use because it combines the features of calculus, algebra, and geometry, which supports the construction of lines, points, and all conic sections, so this geometry software is dynamic (Birgin & Acar, 2020; Ishartono et al., 2022). Geogebra has a menu that is presented complete with icons that are easy to understand to make learning more interactive (Rohaeti & Bernard, 2018). Alkhateeb and Al-Duwairi (2019), also said Geogebra Software with features that make it easier for teachers and teachers to interact to solve math problems, has a positive influence and can deepen mathematical critical thinking.

Therefore, this study aims to elaborate mathematical critical thinking skills using GeoGebra software based on students' AQ. In this study, it will be seen whether there is an effect of learning mathematics using GeoGebra software on critical thinking skills in terms of AQ.

2. METHOD

In achieving the objectives of this study, the method used was experimental with posttest only control group design (Table 1) and a quantitative approach. To find out how the effect of mathematics learning treatment using Geogebra software in the experimental group and conventional mathematics learning treatment in the control group on mathematical critical thinking ability (MCTA) based on the adversity quotient (AQ).

Table 1. Post-test only control group design

Category	Treatment	Post-test
Experimental Group	X ₁	O ₁
Control Group	X ₂	O ₂

Table 2 presents the post-test-only control group design where X1 and X2 are the treatments given, X1 is the treatment in the experimental group by applying Mathematics learning using Geogebra and X2 is the treatment in the control group by applying conventional Mathematics learning. While O1 and O2 represent the experimental and control groups respectively. The population in this study were students who were at the high school level in the city of Jakarta. Meanwhile, as many as 80 samples of class XI students were selected purposively from four parallel classes where each class consisted of 40 students.

The approach in this research is quantitative in the form of the results of student learning abilities, therefore the instrument used is in the form of tests and non-tests that have been validated. The test instrument is based on students' MCTA (Mathematical Critical Thinking Ability), while the non-test instrument is in the form of an AQ (Adversity Quotient) questionnaire containing positive and negative statements and adapted from (Alyani & Zahra, 2020). The validity and reliability of the two instruments were carried out using the Rasch Model in Table 2 below based on the criteria (Sumintono & Widhiarso, 2014). The Rasch model is used because it can measure from a logit scale, display wright maps, see student distributions, and predict bias in missing data and dates (Ölmez & Ölmez, 2019).

Table 2. Fit indices

Statistics	Fit Indices
Point Measure Correlation (PTMEA-CORR)	0.4 – 0.85
Outfit Z-Standardized Values (ZSTD)	(-2.0) – (+2.0)
Outfit Mean Square Values (MNSQ)	0.5 – 1.5

Commented [RVA6]: METHOD:

A good method contains: research design/procedures, population and samples, how data is collected and the tools/instruments used (instrumental grids and instrument validity tests), how the data is analyzed which is described in more detail.

The validation process is carried out by two expert validators and then tested on students to see validity and reliability. The results show that the average of all items on the test and non-test questions are valid and reliable with Cronbach's Alpha of 0.93 for the AQ instrument and 0.86 for the MCTA test questions in 208 students are in the very high category (Faradillah & Febriani, 2021). Thus, it can be used to be tested on students in the experimental group and the control group. For example, non-test and test instruments can be seen in Figures 1 and 2 below.

Seorang pedagang kaki lima sedang mengamati salah satu pengunjung taman yang sedang berlari pagi mengitari taman berbentuk lingkaran dengan jarak lintasan pengunjung tersebut terhadap pusat taman 6 m, sedangkan jarak pedagang terhadap pusat taman 12 m. Misalkan posisi tempat pedagang melihat sebagai titik koordinat dalam meter dan pusat lingkaran terdapat pada sumbu- x , tentukan persamaan lintasan pengunjung dan buatlah grafik persamaan lingkaran.

Figure 1. Test instrument on adversity quotient

- . Saya berpartisipasi mengikuti lomba olimpiade.
- a. Penyebab saya berpartisipasi mengikuti lomba olimpiade adalah sesuatu yang :
- | | | | | | | |
|---------------------|---|---|---|---|---|----------------------|
| Diluar kendali saya | 1 | 2 | 3 | 4 | 5 | Dibawah kendali saya |
| | | | | | | C+ |
- b. Penyebab saya berpartisipasi mengikuti lomba olimpiade dikarenakan:
- | | | | | | | |
|--------------|---|---|---|---|---|-----------------------------|
| Saya sendiri | 1 | 2 | 3 | 4 | 5 | orang lain atau faktor lain |
| | | | | | | O, + |

Figure 2. Test instrument on mathematical critical thinking ability

The data generated will go through an analysis process using the Cohen's d Effect Size Test and Spearman Correlation to answer the research question, namely knowing the effect given by the GeoGebra-based Mathematics learning treatment in the experimental class with conventional learning in the control class. The decision-making criteria in the Effect Size Test use the interpretation presented in table 3 (Sawilowsky, 2009). Before the Cohen's d Effect Size test, Mann Whitney was first tested. The Mann Whitney test was conducted to determine whether or not there were differences in the data groups. The analysis of this hypothesis test was carried out through IBM SPSS 25.

Table 3. Estimated values of effect size

Estimated Values	Size of Effect
0 - 0.01	Very Small
0.01 - 0.2	Small
0.2 - 0.5	Medium
0.5 - 0.8	Large
0.8 - 1.2	Very Large
1.2 - 2.0	Huge

3. RESULT AND DISCUSSION

Result

Mann Whitney statistical test in the control and experimental groups using the logit value of the test results with the Rasch Model obtained on both AQ variables and mathematical critical thinking skills are presented in Table 4.

Commented [RVA7]: RESULT:

The section contains an explanation of the results of the analysis, answers research questions, contains the results of clean data analysis, and refers to the method used

Table 4. Mann whitney test of mathematical critical thinking ability and AQ

		MCTA		AQ	
		Eksperiment	Control	Eksperiment	Control
N	Valid	40	40	40	40
	Missing	0	0	0	0
Median		0.99	0.01	0.56	-0.12
Mann-Whitney U		94.00		93.50	
Asymp. Sig. (2-tailed)		.000		.000	

Table 4 shows that the MCTA of students in the control class with a median = 0.01 is significantly lower than the experimental class student's median = 0.99. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. On the other hand, the adversity quotient of students in the control class with a median = -0.12 was significantly lower than that of the experimental class, median = 0.56. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. So that it shows that there is a significant difference between the control and experimental groups on students' MCTA and AQ.

Table 5. Effect size cohen's d test of experiment and control group toward MCTA and AQ

Aspect	Control Group		Experimental Group		
	Mean	SD	Mean	SD	d
MCTA	0.057	0.441	1.211	0.719	1.934
AQ	-0.125	0.275	0.533	0.256	2.519

Table 5 shows the Cohen's d Effect Size test value based on the logit value on Winstep. The results obtained that the experimental group on the adversity quotient aspect has the most significant effect size with a large effect of 2,519 and is in a large category. Furthermore, in the experimental group, the aspect of mathematical critical thinking ability (KBKM) has a d value of 1,934 which is also categorized as a large category.

Table 6. Spearman correlation test of MCTA and AQ

		KBKM	Adversity
MCTA (Mathematical Critical Thinking Ability)	Correlation Coefficient	1.000	0.918**
	Sig. (2-tailed)	.	0.001
	N	80	80
AQ (Adversity Quotient)	Correlation Coefficient	0.918**	1.000
	Sig. (2-tailed)	.001	.
	N	80	80

**Correlation is significant at the 0.01 level

Table 6 shows the results of the Spearman correlation test with the Logit value obtained between MCTA and AQ in the experimental class using Geogebra-based learning of $0.001 < 0.05$. The correlation coefficient value of 0.918 with a percentage of 91.8% shows a very strong correlation between mathematical critical thinking skills and the adversity quotient. So it shows a significant influence and correlation between MCTA and AQ.

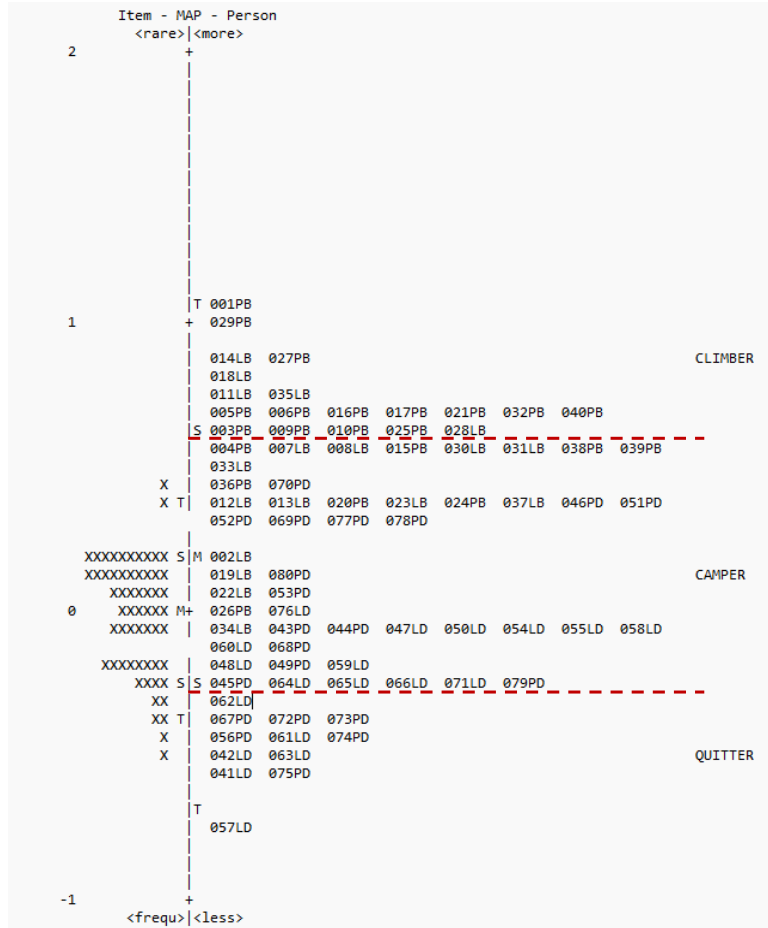


Figure 3. The wright maps on adversity quotient

Figure 3 shows the WinSteps data based on the Wright Maps table. Data came from 80 respondents who filled out the adversity quotient questionnaire and analyzed using WinSteps. Characteristics of respondents based on the type of camper, climber, and quitter shown in the right column are given a numerical code indicating the respondent's number and a letter code indicating gender and class. Meanwhile, the distribution of items (questionnaire items) is shown in the left column. The highest distribution of types is seen in the camper type with a respondent frequency of 49 respondents and the quitter type has the lowest distribution with a respondent frequency of 12 respondents. Camper-type students tend to be easily satisfied with what they receive even though they can produce more (Anggraini & Mahmudi, 2021). In fact, they prefer to be in a zone that they think is safe (Hastuti et al., 2018).

Table 7. Student's quantity based on wright maps AQ

Types of Adversity Quotient	Quantity
Climber	19
Camper	49

Table 7 shows that from 80 students as respondents, there are 12 students who easily give up on facing challenges, in contrast to 19 students who really like challenges. The highest type distribution is in the camper type with 49 students. According to the percentage, there are 15% for quitter type students, 24% for climber type students, and 61% for camper type students.

Discussion

The results of the different tests in Table 4 between the control and experimental groups on Mathematical Critical Thinking Ability and AQ showed a significant difference, the control class was lower than the experimental class. Based on the research results that have been obtained, show that learning mathematics using GeoGebra software influences students' mathematical critical thinking skills. This can be seen through the average logit value score on the achievement of mathematical critical thinking skills of control group students with conventional learning treatment less than experimental group students with mathematics learning treatment using GeoGebra software ($0.057 < 1.211$). This is supported by the value of the Cohen's d Effect Size test which shows the effect in the large category (1.934). In line with the findings that state that learning with the help of GeoGebra software improves students' critical thinking skills compared to learning without the aid of GeoGebra software (Batubara, 2019).

Based on the results of the Spearman correlation test, it was obtained that the mathematical critical thinking ability (KBKM) and the adversity quotient (AQ) in the experimental class using Geogebra-based learning showed a significant effect and correlation between the two ($r = 0.918$, $p < 0.05$) and the percentage was 91.8 %. This is based on the findings that result between AQ and critical thinking skills have a very strong relationship and influence (Rahayu & Alyani, 2020). The relationship between critical thinking skills and adversity quotient can be seen through the type of AQ categorized (Stoltz, 2000). In line with research that states that the achievement of thinking processes is influenced by the three levels in the adversity quotient, namely Climber, Camper, and Quitter (Yanti et al., 2018).

The findings of Asmar and Delyana (2020) state that learning by utilizing GeoGebra software shows the strength of the correlation between critical thinking and independent learning. The use of Geogebra software is also able to improve student learning achievement (Alkhateeb & Al-Duwairi, 2019). This is supported by the finding that GeoGebra supports the construction of lines, points, or all conic sections, therefore this geometry software is dynamic (Birgin & Acar, 2020). Then Supriadi (2015) in his research said that those who used the Geogebra interactive software had higher learning outcomes than those who did not use the Geogebra software.

Based on the results of the Wright Maps AQ of students in the group treated with GeoGebra-assisted learning with students with conventional learning in Figure 3, it can be seen that the distribution of the highest student adversity quotient type is in the camper type with a percentage of 61%. Meanwhile, climber and quitter type students have a percentage of 24% and 15%, respectively. Through Wright Maps, it can also be seen that the adversity quotient of climber type students is dominated by students with learning using GeoGebra and the quitter type is dominated by students with conventional learning.

Rahayu and Alyani (2020) stated that in their research the effect of Adversity Quotient on mathematical critical thinking skills was 75%, especially for the camper type. Wahyu Hidayat and Sari (2019) found that quitter students tend to find it difficult to solve existing problems and are classified as weak in critical thinking achievements. In several studies of the climber type, it was found that students with this type were able to persist in solving

Commented [RVA8]: DISCUSSION:

In the discussion section, sharpen the meaning or interpretation of the data results, compare them with the findings of previous studies and then make generalizations, implications of research results, research limitations and recommendations.

mathematical problems by fulfilling mathematical critical thinking indicators (Rahayu & Alyani, 2020). To find out the distribution of students' mathematical critical thinking skills with learning treatment using GeoGebra and conventional learning treatments, researchers divided the results of mathematical critical thinking skills that can be seen through three types of AQ taken from Table 6.

2. Dik: 1. lingkaran $1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 2. lingkaran $2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Dit: Kelapangan dan titik singgung kedua lingkaran
 Jawab: $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 4. The response of students with AQ quitter

Identification : Given the equation of the circle $1 = x^2 + y^2 - 12x - 12y + 36 = 0$ and
 Equation of circle $2 = x^2 + y^2 + 8x - 12y + 36 = 0$.
 Asked, the position and the point of tangency of the two circles?
 Analysis : $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 5. The process of MCTA of students with AQ quitter

Figures 4 and 5 show the results of students working with code 042LD with the quitter type who have difficulty completing the analysis stage. Students who are in the control class with conventional learning are only able to fulfill the identification and analysis indicators, however, the analysis indicators cannot complete completely. This indicates that students with the quitter type AQ are weak and give up easily in analyzing a problem which affects mathematical critical thinking skills (Brown et al., 2010; Wahyu Hidayat & Sari, 2019; Pangma et al., 2009; Rahayu & Alyani, 2020).

$L_1 : x^2 + y^2 - 12x - 12y + 36 = 0$	P6C
$L_2 : x^2 + y^2 + 8x - 12y + 36 = 0$	$(0+4)(x+4) + (6-6)(y-6) = 16$
$L_1 : (x-6)^2 + (y-6)^2 - 36 - 36 + 36 = 0$	$4(x+4) = 16$
$(x-6)^2 + (y-6)^2 = 36$	$x+4 = 4$
$P(6, 6)$	$x = 0$
$r = 6$	$= 4+4$
$L_2 : (x+4)^2 + (y-6)^2 - 16 - 36 + 36 = 0$	$(0-6)(x-6) + (6-6)(y-6) = 36$
$(x+4)^2 + (y-6)^2 = 16$	$-6(x-6) = 36$
$P(-4, 6)$	$x-6 = -6$
$r = 4$	$x = 0$
P6S dalam kedua lingkaran melalui titik $(0, 6)$	

Figure 6. The response of students with AQ camper

Identification : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Analysis : $L_1 = (x - 6)^2 + (y - 6)^2 - 36 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 36$
 $P(6,6)$
 $r = 6$
 $L_2 = (x - 4)^2 + (y - 6)^2 - 16 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 16$
 $P(-4,6)$
 $r = 4$
 Evaluation : Equation of tangent $(0 + 4)(x + 4) + (6 - 6)(y - 6) = 16$
 $4(x + 4) = 16$
 $x + 4 = 4$
 $x = 0$ or
 $(0 - 6)(x - 6) + (6 - 6)(y - 6) = 36$
 $-6(x - 6) = 36$
 $x - 6 = -6$
 $x = 0$
 The equation of the tangent to the two circles through the point $(0,6)$.

Figure 7. The process of MCTA of students with AQ camper

Figures 6 and 7 above show the results of students working with code 038PB with a camper type that can complete up to the evaluation stage. Students who are given a learning approach using Geogebra software can meet the identification, analysis, and evaluation indicators, but not on the inferential indicators. In this evaluation indicator, students can determine the position of the two circles but it is not written down. This indicates that students with camper type AQ belong to the medium category (Wahyu Hidayat et al., 2018). This type is easily satisfied with what is being done and sometimes does not see the possibilities (Alyani & Zahra, 2020; Rahayu & Alyani, 2020).

2. Diketahui : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ berpusatung
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$ pada titik lain.
 Ditanyakan : Tentukan kedua garis.
 Diketahui : * $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(-12), -\frac{1}{2}(-12))$
 $= (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{6^2 + 6^2 - 36}$
 $= \sqrt{36 + 36 - 36}$
 $= \sqrt{72 - 36}$
 $= \sqrt{36} = 6$
 * $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(8), -\frac{1}{2}(-12))$
 $= (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{(-4)^2 + 6^2 - 36}$
 $= \sqrt{16 + 36 - 36}$
 $= \sqrt{52 - 36}$
 $= \sqrt{16} = 4$
 * Menentukan radikal
 $AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ disamping
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2}$ $AB = r_1 + r_2$
 $= \sqrt{(-10)^2 + 0^2}$ $10 = 6 + 4$
 $= \sqrt{100} = 10$
 Jadi, kedudukan kedua garis adalah berimpitan.

Figure 8. The response of students with AQ climber

Judul Artikel

Identification : We know that $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ dan $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$. (Intersect at a point)
 Asked, position of the two lines.
 Analysis : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $r_1 = \sqrt{6^2 + 6^2 - 36} = \sqrt{36 + 36 - 36} = \sqrt{36} = 6$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $r_2 = \sqrt{(-4)^2 + 6^2 - 36} = \sqrt{16 + 36 - 36} = \sqrt{16} = 4$
 Evaluation : Determine position :
 $P_1P_2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2} = \sqrt{(-10)^2 + (0)^2} = \sqrt{100} = 10$
 Inference : It is concluded that $P_1P_2 = r_1r_2 = 6 + 4 = 10$. So, the position of the two lines is an external tangent.

Figure 9. The process of MCTA of students with AQ climber

Figures 8 and 9 above show the results of students working with code 001PB with a climber type that can solve problems easily. Students who are given a learning approach using GeoGebra software can meet all indicators of identification, analysis, evaluation, and inference. In indicators of identification and analysis, students can understand the concept of the equation of a circle in determining the radius and center of the provided equation. So, on the evaluation indicators, the results obtained and the conclusions on the inference indicators can be written correctly. This indicates that students with climber type AQ can survive to find that the solution they get is right (Wahyu Hidayat & Sari, 2019; Oliveros, 2014; Phoolka & Kaur, 2012). This type is easily satisfied with what he can and does and sometimes ignores the possibilities obtained and belongs to the good AQ category (Alyani & Zahra, 2020). This is in line with the characteristics of the climber type AQ, which can use various solutions and has a persistent and courageous nature (Hidayat et al., 2016).

4. CONCLUSION

Learning mathematics using GeoGebra software has a significant effect on students' mathematical critical thinking skills, showing an influence in large categories and having a good relationship. Meanwhile, students are dominated by camper type AQ. Therefore, students with learn mathematics using GeoGebra software have better mathematical critical thinking skills than students with conventional mathematics learning. Based on the Wright Maps adversity quotient, climber-type students are dominated by students who study using GeoGebra. While the quitter type is dominated by students with conventional learning. This is supported by the results of field findings which show that students with learning using Geogebra software are more active and enthusiastic in learning compared to students with conventional learning.

Based on the results of the research that has been done, teachers can apply learning using the GeoGebra application or other applications that can support learning. In the future, researchers can explore the media used in learning with more contrasting variables and subjects.

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Commented [RVA9]: CONCLUSION:

Conclusions are only sufficient to answer the problem or purpose, or can also produce a new theory/concept based on existing facts/analysis

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The Effect of Learning Using Geogebra Software on Mathematical Critical Thinking Ability Based on Adversity Quotient

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Abstrak

Penelitian ini ialah penelitian kuantitatif eksperimen dengan tujuan mengetahui pengaruh pembelajaran menggunakan *software GeoGebra* terhadap kemampuan berpikir kritis matematis berdasarkan *adversity quotient*. Populasi penelitian ini yaitu siswa SMA kelas XII di Jakarta dan sampel yaitu 40 siswa yang berasal dari kelas eksperimen dan 40 siswa berasal dari kelas kontrol dengan pembelajaran konvensional dan dipilih secara purposive. Instrumen tes didasarkan pada penilaian kemampuan kritis matematis dan non-tes berupa angket *adversity quotient*. Hasil yang diperoleh dari pembelajaran matematika menggunakan *software GeoGebra* memiliki kemampuan berpikir kritis lebih baik dari siswa dengan pembelajaran matematika konvensional. Berdasarkan *Wright Maps*, *adversity quotient* siswa tipe *climber* didominasi oleh siswa dengan pembelajaran menggunakan *GeoGebra*. Sementara tipe *quitter* didominasi oleh siswa dengan pembelajaran konvensional.

Kata kunci: *Adversity Quotient*; Kemampuan Berpikir Kritis Matematis; *Geogebra Software*

Abstract

This research is experimental quantitative research with the aim of knowing the effect of learning mathematics using GeoGebra software on mathematical critical thinking skills based on the adversity quotient. The population of this research is high school students of class XII in Jakarta and the sample is 40 students from the experimental class and 40 students from the control class with conventional learning and selected purposively. The test instrument is based on an assessment of critical mathematical abilities and a non-test in the form of an adversity quotient questionnaire. The results obtained from learning mathematics using GeoGebra software have better critical thinking skills than students with conventional mathematics learning. Based on the Wright Maps adversity quotient climber-type students are dominated by students who study using GeoGebra. While the quitter type is dominated by students with conventional learning.

Keywords: *Adversity Quotient*; Mathematical Critical Thinking Ability; *Geogebra Software*

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1. INTRODUCTION

Mathematical critical thinking is the foundation of the thinking process in generating ideas, analysing arguments, and developing a logical mindset (Dhayanti et al., 2018; Wahyu Hidayat & Sari, 2019; Wechsler et al., 2018). The thought process in question is carried out, so that in learning not only remember and know the concept but to the stage of developing a mindset and applying it in a structured manner. For this, Batubara (2019) states that critical thinking is not only able to remember or know the concepts that have been studied but, in the process, can express again with other easy-to-understand concepts, interpret data and apply concepts based on structured logical thinking patterns.

Referring to the content standards contained in primary and secondary education units in mathematics subjects by teachers, among others, there are analytical, logical, creative, systematic, and critical thinking skills, that can work together (Asmar & Delyana, 2020). The re-application of mathematical critical thinking skills in the 2013 curriculum has the aim that, in learning, students will be able to start thinking critically (Wulandari, 2020). Because they need critical thinking skills to overcome their problems in life (Delina et al., 2018). Paul and

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Refine the introduction.

1. **GAP Analysis:** Explaining the gap between the expectations to be achieved and the facts/conditions that are currently happening (the gap between *das sollen* and *das sein*). So that raises an urgency for conducting research on the chosen topic.

2. **State of Art:** Explains how the development of existing research (which has been published in articles in reputable journals) is related to the topic being researched. Then explain the novelty / novelty value of the research carried out.

3. The purpose of the research, explaining the purpose of carrying out the research in a straightforward and unequivocal manner, accompanied by the delivery of things that are expected from the results of the research conducted. 4. For supporting references in the introduction, it is better to use articles from journals with SINTA and SCOPUS status, published in the last 3-5 years. reference at least 2 sources in each statement to strengthen the statement presented, for example (Putra, 2019; Putri, 2020)

5. Improve the procedure for citing according to the guidelines for authors,

6. Avoid using words according to A... statement first, then author and year

Elder (2019) developed indicators of critical thinking skills which include the identification process, analysis of the results of identification, then evaluation, and finally the conclusion process. Based on this, critical thinking skills are important for students to have because they can develop a logical mindset, can think rationally, and apply them in dealing with problems in the learning process.

However, the importance of critical thinking skills is not accompanied by an optimal learning approach and one's initial abilities, so it influences studies related to the results of skills in mathematical critical thinking. This is based on the findings (W. Hidayat & Aripin, 2019) which state that the learning approach and initial abilities cannot meet the achievement of mathematical critical thinking skills. Not only initial abilities and approaches to learning mathematics are the determinants of success, but there is also an attitude factor in it. Mathematical critical thinking according to Rahayu and Alyani (2020) is an ability that demands being able to solve all the problems it is facing. To be able to fight through this challenge, the Adversity Quotient plays an important role in solving the problems in it.

Adversity Quotient (AQ) is a concept that was first put forward by Paul Stolz in measuring how hard a person's struggles and ability to solve problems is also one of the attitude factors that influence mathematical critical thinking skills in mathematics subjects (Rahayu & Alyani, 2020). This can be seen in Quitter's difficulty in solving existing problems and is classified as weak in critical thinking achievement, namely at an average score of 4.27 (Sari & Hidayat, 2019). Adversity quotient is divided into three types: Climber, Camper, and Quitter. In this initial type (Climber), whatever pressure a person faces will tend to be able to persist in solving the problems at hand. The second type (Campers) tend to be satisfied with what they get and don't want to take high risks. Then, in the third type (Quitters) a person tends not to want to try to be able to solve the problem, and gives up easily. So that the three types can also be used as indicators of a person facing difficulties (Wahyu Hidayat et al., 2018; Wulandari, 2020). Wahyu Hidayat & Sari (2019) stated that the adversity quotient plays a role in influencing the achievement of mathematical critical thinking skills. This is supported by research that reveals the effect of Adversity Quotient on mathematical critical thinking skills by 75%, especially for the camper type (Rahayu & Alyani, 2020). Through the ability to solve a challenge, one can train one's mathematical critical thinking skills (Supandi & Senam, 2020). So mathematical critical thinking skills are very important because they influence the Adversity Quotient aspect.

There have been several studies in recent years related to the adversity quotient, namely, Rahayu & Alyani (2020), Wahyu Hidayat & Sari (2019), Wahyu Hidayat et al. (2018), Yanti et al. (2018). Rahayu & Alyani (2020) discuss that the largest distribution of AQ type is in the camper type by 69.23%, and 75% of AQ has an influence on mathematical critical thinking ability while the rest comes from external factors. Wahyu Hidayat and Sari (2019) stated that the lowest achievement when solving questions was seen in the quitter type students and the highest in the camper type. Thus, the influence given by AQ on the achievement of critical thinking is good. Wahyu Hidayat et al. (2018) in their research found that AQ had a large effect on the argumentation ability of prospective teachers by 60.2% and other factors 39.8%. Then Yanti et al. (2018) show that climber 1 students can fulfill all wallas indicators with moderate completeness, climber 2 students have difficulty on several indicators so climber 2 students have creative abilities in the medium category.

Developments and changing times require humans to be able to think critically, logically, creatively, take initiative and be adaptive to change (Yanti et al., 2018). This requires rapid technological developments with both positive and negative impacts on life, including in the world of education through learning media. Batubara (2019) stated that mathematical critical thinking skills increased with the help of learning media in the form of GeoGebra software compared to without GeoGebra software. Geogebra is an open-source

mathematical software program that can be accessed by anyone with an internet network. Not only that, this software is easy to use because it combines the features of calculus, algebra, and geometry, which supports the construction of lines, points, and all conic sections, so this geometry software is dynamic (Birgin & Acar, 2020; Ishartono et al., 2022). Geogebra has a menu that is presented complete with icons that are easy to understand to make learning more interactive (Rohaeti & Bernard, 2018). Alkhateeb and Al-Duwairi (2019), also said Geogebra Software with features that make it easier for teachers and teachers to interact to solve math problems, has a positive influence and can deepen mathematical critical thinking.

Therefore, this study aims to elaborate mathematical critical thinking skills using GeoGebra software based on students' AQ. In this study, it will be seen whether there is an effect of learning mathematics using GeoGebra software on critical thinking skills in terms of AQ.

2. METHOD

In achieving the objectives of this study, the method used was experimental with posttest only control group design (Table 1) and a quantitative approach. To find out how the effect of mathematics learning treatment using Geogebra software in the experimental group and conventional mathematics learning treatment in the control group on mathematical critical thinking ability (MCTA) based on the adversity quotient (AQ).

Table 1. Post-test only control group design

Category	Treatment	Post-test
Experimental Group	X ₁	O ₁
Control Group	X ₂	O ₂

Table 2 presents the post-test-only control group design where X1 and X2 are the treatments given, X1 is the treatment in the experimental group by applying Mathematics learning using Geogebra and X2 is the treatment in the control group by applying conventional Mathematics learning. While O1 and O2 represent the experimental and control groups respectively. The population in this study were students who were at the high school level in the city of Jakarta. Meanwhile, as many as 80 samples of class XI students were selected purposively from four parallel classes where each class consisted of 40 students.

The approach in this research is quantitative in the form of the results of student learning abilities, therefore the instrument used is in the form of tests and non-tests that have been validated. The test instrument is based on students' MCTA (Mathematical Critical Thinking Ability), while the non-test instrument is in the form of an AQ (Adversity Quotient) questionnaire containing positive and negative statements and adapted from (Alyani & Zahra, 2020). The validity and reliability of the two instruments were carried out using the Rasch Model in Table 2 below based on the criteria (Sumintono & Widhiarso, 2014). The Rasch model is used because it can measure from a logit scale, display wright maps, see student distributions, and predict bias in missing data and dates (Ölmez & Ölmez, 2019).

Table 2. Fit indices

Statistics	Fit Indices
Point Measure Correlation (PTMEA-CORR)	0.4 – 0.85
Outfit Z-Standardized Values (ZSTD)	(-2.0) – (+2.0)
Outfit Mean Square Values (MNSQ)	0.5 – 1.5

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The method needs to be explained clearly, it can be described in four paragraphs, which includes:

- 1.The type and design of the research,
- 2.The research subject.
- 3.The data collection method and the instrument (complete with a grid and test the validity of the instrument.
- Method of analysis (analysis performed).

The validation process is carried out by two expert validators and then tested on students to see validity and reliability. The results show that the average of all items on the test and non-test questions are valid and reliable with Cronbach's Alpha of 0.93 for the AQ instrument and 0.86 for the MCTA test questions in 208 students are in the very high category (Faradillah & Febriani, 2021). Thus, it can be used to be tested on students in the experimental group and the control group. For example, non-test and test instruments can be seen in Figures 1 and 2 below.

Seorang pedagang kaki lima sedang mengamati salah satu pengunjung taman yang sedang berlari pagi mengitari taman berbentuk lingkaran dengan jarak lintasan pengunjung tersebut terhadap pusat taman 6 m, sedangkan jarak pedagang terhadap pusat taman 12 m. Misalkan posisi tempat pedagang melihat sebagai titik koordinat dalam meter dan pusat lingkaran terdapat pada sumbu- x , tentukan persamaan lintasan pengunjung dan buatlah grafik persamaan lingkaran.

Figure 1. Test instrument on adversity quotient

- . Saya berpartisipasi mengikuti lomba olimpiade.
- a. Penyebab saya berpartisipasi mengikuti lomba olimpiade adalah sesuatu yang :
- | | | | | | | |
|---------------------|---|---|---|---|---|----------------------|
| Diluar kendali saya | 1 | 2 | 3 | 4 | 5 | Dibawah kendali saya |
| | | | | | | C+ |
- b. Penyebab saya berpartisipasi mengikuti lomba olimpiade dikarenakan:
- | | | | | | | |
|--------------|---|---|---|---|---|-----------------------------|
| Saya sendiri | 1 | 2 | 3 | 4 | 5 | orang lain atau faktor lain |
| | | | | | | O, + |

Figure 2. Test instrument on mathematical critical thinking ability

The data generated will go through an analysis process using the Cohen's d Effect Size Test and Spearman Correlation to answer the research question, namely knowing the effect given by the GeoGebra-based Mathematics learning treatment in the experimental class with conventional learning in the control class. The decision-making criteria in the Effect Size Test use the interpretation presented in table 3 (Sawilowsky, 2009). Before the Cohen's d Effect Size test, Mann Whitney was first tested. The Mann Whitney test was conducted to determine whether or not there were differences in the data groups. The analysis of this hypothesis test was carried out through IBM SPSS 25.

Table 3. Estimated values of effect size

Estimated Values	Size of Effect
0 - 0.01	Very Small
0.01 - 0.2	Small
0.2 - 0.5	Medium
0.5 - 0.8	Large
0.8 - 1.2	Very Large
1.2 - 2.0	Huge

3. RESULT AND DISCUSSION

Result

Mann Whitney statistical test in the control and experimental groups using the logit value of the test results with the Rasch Model obtained on both AQ variables and mathematical critical thinking skills are presented in Table 4.

Commented [RVB8]: RESULT:

1. Answer the research objectives based on the method you use in the study
2. Do not present raw data,
3. There is no repetition of the delivery of data results.

Table 4. Mann whitney test of mathematical critical thinking ability and AQ

		MCTA		AQ	
		Eksperiment	Control	Eksperiment	Control
N	Valid	40	40	40	40
	Missing	0	0	0	0
Median		0.99	0.01	0.56	-0.12
Mann-Whitney U		94.00		93.50	
Asymp. Sig. (2-tailed)		.000		.000	

Table 4 shows that the MCTA of students in the control class with a median = 0.01 is significantly lower than the experimental class student's median = 0.99. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. On the other hand, the adversity quotient of students in the control class with a median = -0.12 was significantly lower than that of the experimental class, median = 0.56. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. So that it shows that there is a significant difference between the control and experimental groups on students' MCTA and AQ.

Table 5. Effect size cohen's d test of experiment and control group toward MCTA and AQ

Aspect	Control Group		Experimental Group		
	Mean	SD	Mean	SD	d
MCTA	0.057	0.441	1.211	0.719	1.934
AQ	-0.125	0.275	0.533	0.256	2.519

Table 5 shows the Cohen's d Effect Size test value based on the logit value on Winstep. The results obtained that the experimental group on the adversity quotient aspect has the most significant effect size with a large effect of 2,519 and is in a large category. Furthermore, in the experimental group, the aspect of mathematical critical thinking ability (KBKM) has a d value of 1,934 which is also categorized as a large category.

Table 6. Spearman correlation test of MCTA and AQ

		KBKM	Adversity
MCTA (Mathematical Critical Thinking Ability)	Correlation Coefficient	1.000	0.918**
	Sig. (2-tailed)	.	0.001
	N	80	80
AQ (Adversity Quotient)	Correlation Coefficient	0.918**	1.000
	Sig. (2-tailed)	.001	.
	N	80	80

**Correlation is significant at the 0.01 level

Table 6 shows the results of the Spearman correlation test with the Logit value obtained between MCTA and AQ in the experimental class using Geogebra-based learning of $0.001 < 0.05$. The correlation coefficient value of 0.918 with a percentage of 91.8% shows a very strong correlation between mathematical critical thinking skills and the adversity quotient. So it shows a significant influence and correlation between MCTA and AQ.

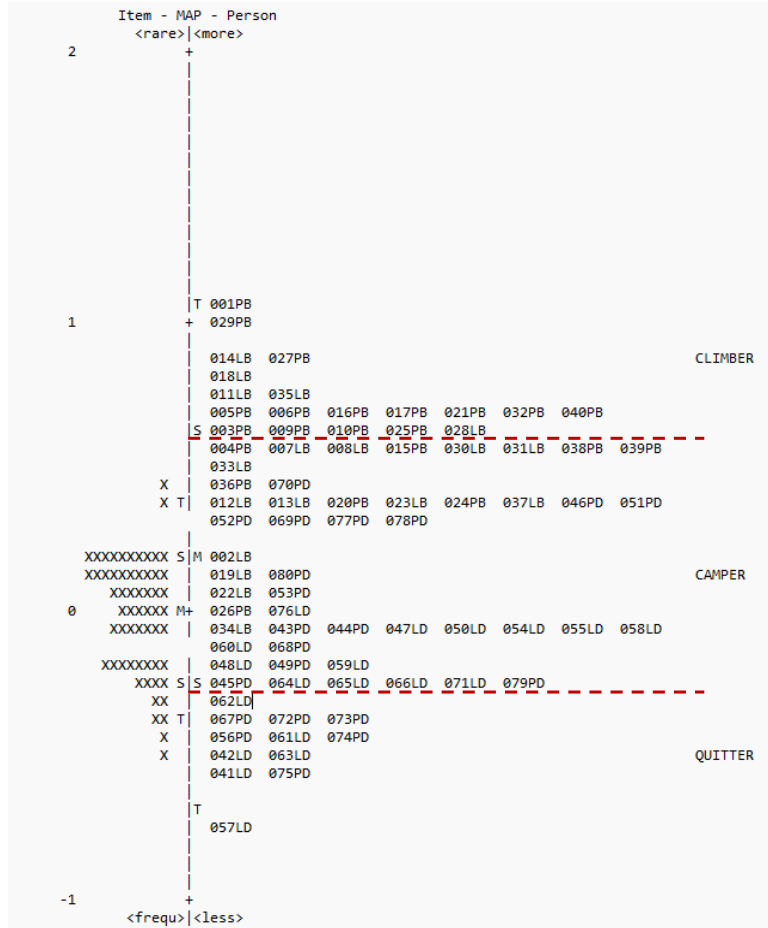


Figure 3. The wright maps on adversity quotient

Figure 3 shows the WinSteps data based on the Wright Maps table. Data came from 80 respondents who filled out the adversity quotient questionnaire and analyzed using WinSteps. Characteristics of respondents based on the type of camper, climber, and quitter shown in the right column are given a numerical code indicating the respondent's number and a letter code indicating gender and class. Meanwhile, the distribution of items (questionnaire items) is shown in the left column. The highest distribution of types is seen in the camper type with a respondent frequency of 49 respondents and the quitter type has the lowest distribution with a respondent frequency of 12 respondents. Camper-type students tend to be easily satisfied with what they receive even though they can produce more (Anggraini & Mahmudi, 2021). In fact, they prefer to be in a zone that they think is safe (Hastuti et al., 2018).

Table 7. Student's quantity based on wright maps AQ

Types of Adversity Quotient	Quantity
Climber	19
Camper	49

Quitter	12
---------	----

Table 7 shows that from 80 students as respondents, there are 12 students who easily give up on facing challenges, in contrast to 19 students who really like challenges. The highest type distribution is in the camper type with 49 students. According to the percentage, there are 15% for quitter type students, 24% for climber type students, and 61% for camper type students.

Discussion

The results of the different tests in Table 4 between the control and experimental groups on Mathematical Critical Thinking Ability and AQ showed a significant difference, the control class was lower than the experimental class. Based on the research results that have been obtained, show that learning mathematics using GeoGebra software influences students' mathematical critical thinking skills. This can be seen through the average logit value score on the achievement of mathematical critical thinking skills of control group students with conventional learning treatment less than experimental group students with mathematics learning treatment using GeoGebra software ($0.057 < 1.211$). This is supported by the value of the Cohen's d Effect Size test which shows the effect in the large category (1.934). In line with the findings that state that learning with the help of GeoGebra software improves students' critical thinking skills compared to learning without the aid of GeoGebra software (Batubara, 2019).

Based on the results of the Spearman correlation test, it was obtained that the mathematical critical thinking ability (KBKM) and the adversity quotient (AQ) in the experimental class using Geogebra-based learning showed a significant effect and correlation between the two ($r = 0.918$, $p < 0.05$) and the percentage was 91.8 %. This is based on the findings that result between AQ and critical thinking skills have a very strong relationship and influence (Rahayu & Alyani, 2020). The relationship between critical thinking skills and adversity quotient can be seen through the type of AQ categorized (Stoltz, 2000). In line with research that states that the achievement of thinking processes is influenced by the three levels in the adversity quotient, namely Climber, Camper, and Quitter (Yanti et al., 2018).

The findings of Asmar and Delyana (2020) state that learning by utilizing GeoGebra software shows the strength of the correlation between critical thinking and independent learning. The use of Geogebra software is also able to improve student learning achievement (Alkhateeb & Al-Duwairi, 2019). This is supported by the finding that GeoGebra supports the construction of lines, points, or all conic sections, therefore this geometry software is dynamic (Birgin & Acar, 2020). Then Supriadi (2015) in his research said that those who used the Geogebra interactive software had higher learning outcomes than those who did not use the Geogebra software.

Based on the results of the Wright Maps AQ of students in the group treated with GeoGebra-assisted learning with students with conventional learning in Figure 3, it can be seen that the distribution of the highest student adversity quotient type is in the camper type with a percentage of 61%. Meanwhile, climber and quitter type students have a percentage of 24% and 15%, respectively. Through Wright Maps, it can also be seen that the adversity quotient of climber type students is dominated by students with learning using GeoGebra and the quitter type is dominated by students with conventional learning.

Rahayu and Alyani (2020) stated that in their research the effect of Adversity Quotient on mathematical critical thinking skills was 75%, especially for the camper type. Wahyu Hidayat and Sari (2019) found that quitter students tend to find it difficult to solve existing problems and are classified as weak in critical thinking achievements. In several studies of the climber type, it was found that students with this type were able to persist in solving

Commented [RVB9]: DISCUSSION:

Please sharpen the discussion or discussion regarding:

1. The meaning of the research results,
2. Comparing research results with previous theories/research (each reference statement uses at least 2 sources to strengthen the statement presented)
3. Research advantages.
4. Contribution of research results.
5. Implications
6. Research limitations and recommendations for future researchers (suggestions)

mathematical problems by fulfilling mathematical critical thinking indicators (Rahayu & Alyani, 2020). To find out the distribution of students' mathematical critical thinking skills with learning treatment using GeoGebra and conventional learning treatments, researchers divided the results of mathematical critical thinking skills that can be seen through three types of AQ taken from Table 6.

Dik: 1. lingkaran $1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 2. lingkaran $2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Dit: Kelapangan dan titik singgung kedua lingkaran
 Jawab: $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12) \right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12) \right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 4. The response of students with AQ quitter

Identification : Given the equation of the circle $1 = x^2 + y^2 - 12x - 12y + 36 = 0$ and
 Equation of circle $2 = x^2 + y^2 + 8x - 12y + 36 = 0$.
 Asked, the position and the point of tangency of the two circles?
 Analysis : $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12) \right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12) \right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 5. The process of MCTA of students with AQ quitter

Figures 4 and 5 show the results of students working with code 042LD with the quitter type who have difficulty completing the analysis stage. Students who are in the control class with conventional learning are only able to fulfill the identification and analysis indicators, however, the analysis indicators cannot complete completely. This indicates that students with the quitter type AQ are weak and give up easily in analyzing a problem which affects mathematical critical thinking skills (Brown et al., 2010; Wahyu Hidayat & Sari, 2019; Pangma et al., 2009; Rahayu & Alyani, 2020).

$L_1 : x^2 + y^2 - 12x - 12y + 36 = 0$	P6C
$L_2 : x^2 + y^2 + 8x - 12y + 36 = 0$	$(0+4)(x+4) + (6-6)(y-6) = 16$
$L_1 : (x-6)^2 + (y-6)^2 - 36 - 36 + 36 = 0$	$4(x+4) = 16$
$(x-6)^2 + (y-6)^2 = 36$	$x+4 = 4$
$P(6, 6)$	$x = 0$
$r = 6$	$= 4+4$
$L_2 : (x+4)^2 + (y-6)^2 - 16 - 36 + 36 = 0$	$(0-6)(x-6) + (6-6)(y-6) = 36$
$(x+4)^2 + (y-6)^2 = 16$	$-6(x-6) = 36$
$P(-4, 6)$	$x-6 = -6$
$r = 4$	$x = 0$
P6S dalam kedua lingkaran melalui titik $(0, 6)$	

Figure 6. The response of students with AQ camper

Identification : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Analysis : $L_1 = (x - 6)^2 + (y - 6)^2 - 36 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 36$
 $P(6,6)$
 $r = 6$
 $L_2 = (x - 4)^2 + (y - 6)^2 - 16 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 16$
 $P(-4,6)$
 $r = 4$
 Evaluation : Equation of tangent $(0 + 4)(x + 4) + (6 - 6)(y - 6) = 16$
 $4(x + 4) = 16$
 $x + 4 = 4$
 $x = 0$ or
 $(0 - 6)(x - 6) + (6 - 6)(y - 6) = 36$
 $-6(x - 6) = 36$
 $x - 6 = -6$
 $x = 0$
 The equation of the tangent to the two circles through the point $(0,6)$.

Figure 7. The process of MCTA of students with AQ camper

Figures 6 and 7 above show the results of students working with code 038PB with a camper type that can complete up to the evaluation stage. Students who are given a learning approach using Geogebra software can meet the identification, analysis, and evaluation indicators, but not on the inferential indicators. In this evaluation indicator, students can determine the position of the two circles but it is not written down. This indicates that students with camper type AQ belong to the medium category (Wahyu Hidayat et al., 2018). This type is easily satisfied with what is being done and sometimes does not see the possibilities (Alyani & Zahra, 2020; Rahayu & Alyani, 2020).

2. Diketahui : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ berpusatung
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$ pada titik lain.
 Ditanyakan : Tentukan kedua garis.
 Diketahui : * $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(-12), -\frac{1}{2}(-12))$
 $= (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{6^2 + 6^2 - 36}$
 $= \sqrt{36 + 36 - 36}$
 $= \sqrt{72 - 36}$
 $= \sqrt{36} = 6$
 * $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(8), -\frac{1}{2}(-12))$
 $= (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{(-4)^2 + 6^2 - 36}$
 $= \sqrt{16 + 36 - 36}$
 $= \sqrt{52 - 36}$
 $= \sqrt{16} = 4$
 * Menentukan persamaan
 $AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ disamping
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2}$ $AB = r_1 + r_2$
 $= \sqrt{(-10)^2 + 0^2}$ $10 = 6 + 4$
 $= \sqrt{100} = 10$
 Jadi, kedudukan kedua garis adalah berimpitan.

Figure 8. The response of students with AQ climber

Judul Artikel

Identification : We know that $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ dan $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$. (Intersect at a point)
 Asked, position of the two lines.
 Analysis : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $r_1 = \sqrt{6^2 + 6^2 - 36} = \sqrt{36 + 36 - 36} = \sqrt{36} = 6$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $r_2 = \sqrt{(-4)^2 + 6^2 - 36} = \sqrt{16 + 36 - 36} = \sqrt{16} = 4$
 Evaluation : Determine position :
 $P_1P_2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2} = \sqrt{(-10)^2 + (0)^2} = \sqrt{100} = 10$
 Inference : It is concluded that $P_1P_2 = r_1r_2 = 6 + 4 = 10$. So, the position of the two lines is an external tangent.

Figure 9. The process of MCTA of students with AQ climber

Figures 8 and 9 above show the results of students working with code 001PB with a climber type that can solve problems easily. Students who are given a learning approach using GeoGebra software can meet all indicators of identification, analysis, evaluation, and inference. In indicators of identification and analysis, students can understand the concept of the equation of a circle in determining the radius and center of the provided equation. So, on the evaluation indicators, the results obtained and the conclusions on the inference indicators can be written correctly. This indicates that students with climber type AQ can survive to find that the solution they get is right (Wahyu Hidayat & Sari, 2019; Oliveros, 2014; Phoolka & Kaur, 2012). This type is easily satisfied with what he can and does and sometimes ignores the possibilities obtained and belongs to the good AQ category (Alyani & Zahra, 2020). This is in line with the characteristics of the climber type AQ, which can use various solutions and has a persistent and courageous nature (Hidayah et al., 2016).

4. CONCLUSION

Learning mathematics using GeoGebra software has a significant effect on students' mathematical critical thinking skills, showing an influence in large categories and having a good relationship. Meanwhile, students are dominated by camper type AQ. Therefore, students with learn mathematics using GeoGebra software have better mathematical critical thinking skills than students with conventional mathematics learning. Based on the Wright Maps adversity quotient, climber-type students are dominated by students who study using GeoGebra. While the quitter type is dominated by students with conventional learning. This is supported by the results of field findings which show that students with learning using Geogebra software are more active and enthusiastic in learning compared to students with conventional learning.

Based on the results of the research that has been done, teachers can apply learning using the GeoGebra application or other applications that can support learning. In the future, researchers can explore the media used in learning with more contrasting variables and subjects.

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Commented [RVB10]: CONCLUSION:

1. Consists of 1 conceptual paragraph that answers the research problem
2. Do not repeat the results and discussion

Commented [RVB11]: REFERENCES:

1. 30-40 references, 90% of reputable journal articles with the SINTA and SCOPUS indexes (minimum 10 Scopus articles), the last 3 years a maximum of 5 years (for journals) and for references from books published in the last 5 years a maximum of 10 years
2. Writing references using the "APA" format of the American Psychological Association.
3. Use the Mendeley app to compile a bibliography
4. References in the form of articles complete with URLs and DOI (make sure they are active/accessible)
5. You can use the references below which would suit your topic.
Link:
<https://ejournal.undiksha.ac.id/index.php/TSCJ>
<https://ejournal.undiksha.ac.id/index.php/IVCEJ>
<https://ejournal.undiksha.ac.id/index.php/JPMu>

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3. Bukti Konfirmasi Review dan Hasil Review Kedua (14 September 2022)



Fitri Alyani <fitrialyani@uhamka.ac.id>

[JPP] Editor Decision

1 message

Ejournal Undiksha <ejournal@undiksha.ac.id>

Wed, Sep 14, 2022 at 3:25 PM

To: Fitri Alyani <fitrialyani@uhamka.ac.id>, Natalia Sartika <nata.dspr@gmail.com>

Fitri Alyani, Natalia Sartika:

We have reached a decision regarding your submission to Jurnal Pendidikan dan Pengajaran, "The Effect of Learning Using Geogebra Software on Mathematical Critical Thinking Ability Based on Adversity Quotient".

Our decision is to: Revision Required

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Students' Mathematical Critical Thinking Using Geogebra Software Based on Adversity Quotient

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Abstrak

Kemampuan berpikir kritis tidak diimbangi dengan optimalnya pendekatan pembelajaran. Hal ini terlihat dari rendahnya capaian kemampuan berpikir kritis matematis. Penelitian ini ialah penelitian kuantitatif eksperimen yang memiliki tujuan mengetahui pengaruh pembelajaran menggunakan *software GeoGebra* terhadap kemampuan berpikir kritis matematis berdasarkan *adversity quotient* (AQ). Rancangan penelitian yang digunakan ialah *Posttest Only Control Group Design*. Populasi penelitian ini yaitu siswa SMA kelas XI pada salah satu sekolah di Jakarta dan sampel yaitu 40 siswa yang berasal dari kelas eksperimen dan 40 siswa berasal dari kelas kontrol dengan pembelajaran konvensional dan dipilih secara purposive. Instrumen tes didasarkan pada penilaian kemampuan kritis matematis dan non-tes berupa angket *adversity quotient*. Data kemudian dianalisis dengan *Mann Whitney U Test*, *Cohen's d Effect Size Test* dan *Spearman Correlation*. Hasil yang diperoleh dari pembelajaran matematika menggunakan *software GeoGebra* memiliki kemampuan berpikir kritis lebih baik dari siswa dengan pembelajaran matematika konvensional. Berdasarkan *Wright Maps*, *adversity quotient* siswa tipe *climber* didominasi oleh siswa dengan pembelajaran menggunakan *GeoGebra*. Sementara tipe *quitter* didominasi oleh siswa dengan pembelajaran konvensional. Kesimpulan penelitian ini, pembelajaran menggunakan *software GeoGebra* memiliki pengaruh terhadap kemampuan berpikir kritis matematis ditinjau dari *Adversity Quotient*.

Kata kunci: *Adversity Quotient*; Kemampuan Berpikir Kritis Matematis; *GeoGebra Software*

Abstract

The ability to think critically is not balanced with an optimal learning approach. This can be seen from the low achievement of mathematical critical thinking skills. This research is an experimental quantitative study that aims to determine the effect of learning using *GeoGebra* software on mathematical critical thinking skills based on the *adversity quotient* (AQ). The research design used was *Posttest Only Control Group Design*. The population of this research is high school students in class XI at one school in Jakarta and the sample is 40 students from the experimental class and 40 students from the control class with conventional learning and selected purposively. The test instrument is based on an assessment of critical mathematical abilities and a non-test in the form of an *adversity quotient* questionnaire. The data were then analyzed by *Mann Whitney U Test*, *Cohen's d Effect Size Test*, and *Spearman Correlation*. The results obtained from learning mathematics using *GeoGebra* software have better critical thinking skills than students with conventional mathematics learning. Based on *Wright Maps*, the *adversity quotient* of climber-type students is dominated by students who study using *GeoGebra*. While the quitter type is dominated by students with conventional learning. The conclusion of this study, learning using *GeoGebra* software has an influence on mathematical critical thinking skills in terms of *Adversity Quotient*.

Keywords: *Adversity Quotient*; Mathematical Critical Thinking Ability; *GeoGebra Software*

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- Existing problems
 - The type and research approach used
 - Research subject
 - Conclusions, and research implications
- Abstract in range of 150-180 words

1. INTRODUCTION

Mathematical critical thinking is the foundation of the thinking process in generating ideas, analyzing arguments, and developing a logical mindset (Dhayanti et al., 2018; Dockendorff & Solar, 2018; Wahyu Hidayat & Sari, 2019; Wechsler et al., 2018). The thought process in question is carried out, so that in learning not only remember and know the concept but to the stage of developing a mindset and applying it in a structured manner. For this, Batubara (2019) states that critical thinking is not only able to remember or know the

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concepts that have been studied but, in the process, can express again with other easy-to-understand concepts, interpret data and apply concepts based on structured logical thinking patterns.

Referring to the content standards contained in primary and secondary education units in mathematics subjects by teachers, among others, there are analytical, logical, creative, systematic, and critical thinking skills, that can work together (Asmar & Delyana, 2020). The re-application of mathematical critical thinking skills in the 2013 curriculum has the aim that, in learning, students will be able to start thinking critically (Wulandari, 2020). Because they need critical thinking skills to overcome their problems in life (Delina et al., 2018). Paul and Elder (2019) developed indicators of critical thinking skills which include the identification process, analysis of the results of identification, then evaluation, and finally the conclusion process. Based on this, critical thinking skills are important for students to have because they can develop a logical mindset, can think rationally, and apply them in dealing with problems in the learning process.

However, the importance of critical thinking skills is not accompanied by an optimal learning approach and one's initial abilities, so it influences studies related to the results of skills in mathematical critical thinking. This is based on the findings (W. Hidayat & Aripin, 2019) which state that the learning approach and initial abilities cannot meet the achievement of mathematical critical thinking skills. Not only initial abilities and approaches to learning mathematics are the determinants of success, but there is also an attitude factor in it. Mathematical critical thinking according to Rahayu and Alyani (2020) is an ability that demands being able to solve all the problems it is facing. To be able to fight through this challenge, the Adversity Quotient plays an important role in solving the problems in it.

Adversity Quotient (AQ) is a concept that was first put forward by Paul Stolz in measuring how hard a person's struggles and ability to solve problems is also one of the attitude factors that influence mathematical critical thinking skills in mathematics subjects (Rahayu & Alyani, 2020). This can be seen in Quitter's difficulty in solving existing problems and is classified as weak in critical thinking achievement, namely at an average score of 4.27 (Sari & Hidayat, 2019). Adversity quotient is divided into three types: Climber, Camper, and Quitter. In this initial type (Climber), whatever pressure a person faces will tend to be able to persist in solving the problems at hand. The second type (Campers) tend to be satisfied with what they get and don't want to take high risks. Then, in the third type (Quitters) a person tends not to want to try to be able to solve the problem, and gives up easily. So that the three types can also be used as indicators of a person facing difficulties (Wahyu Hidayat et al., 2018; Wulandari, 2020). Wahyu Hidayat & Sari (2019) stated that the adversity quotient plays a role in influencing the achievement of mathematical critical thinking skills. This is supported by research that reveals the effect of Adversity Quotient on mathematical critical thinking skills by 75%, especially for the camper type (Rahayu & Alyani, 2020). Through the ability to solve a challenge, one can train one's mathematical critical thinking skills (Supandi & Senam, 2020). So mathematical critical thinking skills are very important because they influence the Adversity Quotient aspect.

There have been several studies in recent years related to the adversity quotient, namely, Rahayu & Alyani (2020), Wahyu Hidayat & Sari (2019), Wahyu Hidayat et al. (2018), Yanti et al. (2018). Rahayu & Alyani (2020) discuss that the largest distribution of AQ type is in the camper type by 69.23%, and 75% of AQ has an influence on mathematical critical thinking ability while the rest comes from external factors. Wahyu Hidayat and Sari (2019) stated that the lowest achievement when solving questions was seen in the quitter type students and the highest in the camper type. Thus, the influence given by AQ on the achievement of critical thinking is good. Wahyu Hidayat et al. (2018) in their research found that AQ had a large effect on the argumentation ability of prospective teachers by 60.2% and other factors 39.8%.

Then Yanti et al. (2018) show that climber 1 students can fulfill all wallas indicators with moderate completeness, climber 2 students have difficulty on several indicators so climber 2 students have creative abilities in the medium category.

Developments and changing times require humans to be able to think critically, logically, creatively, take initiative and be adaptive to change (Yanti et al., 2018). This requires rapid technological developments with both positive and negative impacts on life, including in the world of education through learning media. Batubara (2019) stated that mathematical critical thinking skills increased with the help of learning media in the form of GeoGebra software compared to without GeoGebra software. GeoGebra is an open-source mathematical software program that can be accessed by anyone with an internet network. Not only that, this software is easy to use because it combines the features of calculus, algebra, and geometry, which supports the construction of lines, points, and all conic sections, so this geometry software is dynamic (Birgin & Acar, 2020; Dockendorff & Solar, 2018; Ishartono et al., 2022). GeoGebra has a menu that is presented complete with icons that are easy to understand to make learning more interactive (Rohaeti & Bernard, 2018; Yurniwati & Soleh, 2020). Alkhateeb and Al-Duwairi (2019), also said GeoGebra Software with features that make it easier for teachers and teachers to interact to solve math problems, has a positive influence and can deepen mathematical critical thinking. Thus, the gap in this study is the learning treatment using GeoGebra which was carried out in the experimental class. Thus, the gap in this study is the learning treatment using GeoGebra which was carried out in the experimental class.

Therefore, this study aims to elaborate mathematical critical thinking skills using GeoGebra software based on students' AQ. In this study, it will be seen whether there is an effect of learning mathematics using GeoGebra software on critical thinking skills in terms of AQ.

2. METHOD

In achieving the objectives of this study, the method used was experimental with posttest only control group design (Table 1) and a quantitative approach. To find out how the effect of mathematics learning treatment using GeoGebra software in the experimental group and conventional mathematics learning treatment in the control group on mathematical critical thinking ability (MCTA) based on the adversity quotient (AQ).

Table 1. Post-test only control group design

Category	Treatment	Post-test
Experimental Group	X_1	O_1
Control Group	X_2	O_2

Table 2 presents the post-test-only control group design where X_1 and X_2 are the treatments given, X_1 is the treatment in the experimental group by applying Mathematics learning using GeoGebra and X_2 is the treatment in the control group by applying conventional Mathematics learning. While O_1 and O_2 represent the experimental and control groups respectively. The population in this study were students who were at the high school level in the city of Jakarta. Meanwhile, as many as 80 samples of class XI students were selected purposively from four parallel classes where each class consisted of 40 students.

The approach in this research is quantitative in the form of the results of student learning abilities, therefore the instrument used is in the form of tests and non-tests that have been validated. The test instrument is based on students' MCTA (Mathematical Critical Thinking Ability), while the non-test instrument is in the form of an AQ (Adversity Quotient)

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questionnaire containing 20 positive and 40 negative statements and adapted from (Alyani & Zahra, 2020). The validity and reliability of the two instruments were carried out using the Rasch Model in Table 2 below based on the criteria (Sumintono & Widhiarso, 2014). The Rasch model is used because it can measure from a logit scale, display wright maps, see student distributions, and predict bias in missing data and dates (Ölmez & Ölmez, 2019).

Table 2. Fit indices

Statistics	Fit Indices
Point Measure Correlation (PTMEA-CORR)	0.4 – 0.85
Outfit Z-Standardized Values (ZSTD)	(-2.0) – (+2.0)
Outfit Mean Square Values (MNSQ)	0.5 – 1.5

The validation process is carried out by two expert validators and then tested on students to see validity and reliability. The results show that the average of all items on the test and non-test questions are valid and reliable with Cronbach's Alpha of 0.93 for the AQ instrument and 0.86 for the MCTA test questions in 208 students are in the very high category (Faradillah & Febriani, 2021). Thus, it can be used to be tested on students in the experimental group and the control group. For example, non-test and test instruments can be seen in Figures 1 and 2 below.

Seorang pedagang kaki lima sedang mengamati salah satu pengunjung taman yang sedang berlari pagi mengitari taman berbentuk lingkaran dengan jarak lintasan pengunjung tersebut terhadap pusat taman 6 m, sedangkan jarak pedagang terhadap pusat taman 12 m. Misalkan posisi tempat pedagang melihat sebagai titik koordinat dalam meter dan pusat lingkaran terdapat pada sumbu- x , tentukan persamaan lintasan pengunjung dan buatlah grafik persamaan lingkaran.

Figure 1. Test instrument on adversity quotient

- . Saya berpartisipasi mengikuti lomba olimpiade.
- a. Penyebab saya berpartisipasi mengikuti lomba olimpiade adalah sesuatu yang :
- | | | | | | | |
|---------------------|---|---|---|---|---|----------------------|
| Diluar kendali saya | 1 | 2 | 3 | 4 | 5 | Dibawah kendali saya |
|---------------------|---|---|---|---|---|----------------------|
- C+
- b. Penyebab saya berpartisipasi mengikuti lomba olimpiade dikarenakan:
- | | | | | | | |
|--------------|---|---|---|---|---|-----------------------------|
| Saya sendiri | 1 | 2 | 3 | 4 | 5 | orang lain atau faktor lain |
|--------------|---|---|---|---|---|-----------------------------|
- O_r +

Figure 2. Test instrument on mathematical critical thinking ability

The data generated will go through an analysis process using the Mann Whitney U Test, Cohen's d Effect Size Test and Spearman Correlation to answer the research question, namely knowing the effect given by the GeoGebra-based Mathematics learning treatment in the experimental class with conventional learning in the control class. The decision-making criteria in the Effect Size Test use the interpretation presented in table 3 (Sawilowsky, 2009). Before the Cohen's d Effect Size test, Mann Whitney was first tested. The Mann Whitney test was conducted to determine whether or not there were differences in the data groups. The analysis of this hypothesis test was carried out through IBM SPSS 25.

Table 3. Estimated values of effect size

Estimated Values	Size of Effect
0 - 0.01	Very Small
0.01 - 0.2	Small

0.2 - 0.5	Medium
0.5 - 0.8	Large
0.8 - 1.2	Very Large
1.2 - 2.0	Huge

3. RESULT AND DISCUSSION

Result

Mann Whitney statistical test in the control and experimental groups using the logit value of the test results with the Rasch Model obtained on both AQ variables and mathematical critical thinking skills are presented in Table 4.

Table 4. Mann whitney test of mathematical critical thinking ability and AQ

		MCTA		AQ	
		Eksperiment	Control	Eksperiment	Control
N	Valid	40	40	40	40
	Missing	0	0	0	0
Median		0.99	0.01	0.56	-0.12
Mann-Whitney U		94.00		93.50	
Asymp. Sig. (2-tailed)		.000		.000	

Table 4 shows that the MCTA of students in the control class with a median = 0.01 is significantly lower than the experimental class student's median = 0.99. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. On the other hand, the adversity quotient of students in the control class with a median = -0.12 was significantly lower than that of the experimental class, median = 0.56. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. So that it shows that there is a significant difference between the control and experimental groups on students' MCTA and AQ.

Table 5. Effect size cohen's d test of experiment and control group toward MCTA and AQ

Aspect	Control Group		Experimental Group		
	Mean	SD	Mean	SD	d
MCTA	0.057	0.441	1.211	0.719	1.934
AQ	-0.125	0.275	0.533	0.256	2.519

Table 5 shows the Cohen's d Effect Size test value based on the logit value on Winstep. The results obtained that the experimental group on the adversity quotient aspect has the most significant effect size with a large effect of 2,519 and is in a large category. Furthermore, in the experimental group, the aspect of mathematical critical thinking ability (MCTA) has a d value of 1,934 which is also categorized as a large category.

Table 6. Spearman correlation test of MCTA and AQ

		MCTA	Adversity
MCTA (Mathematical Critical Thinking Ability)	Correlation Coefficient	1.000	0.918**
	Sig. (2-tailed)	.	0.001
	N	80	80
AQ (Adversity Quotient)	Correlation Coefficient	0.918**	1.000
	Sig. (2-tailed)	.001	.
	N	80	80

**Correlation is significant at the 0.01 level

Table 6 shows the results of the Spearman correlation test with the Logit value obtained between MCTA and AQ in the experimental class using GeoGebra-based learning of $0.001 < 0.05$. The correlation coefficient value of 0.918 with a percentage of 91.8% shows a very strong correlation between mathematical critical thinking skills and the adversity quotient. So it shows a significant influence and correlation between MCTA and AQ.

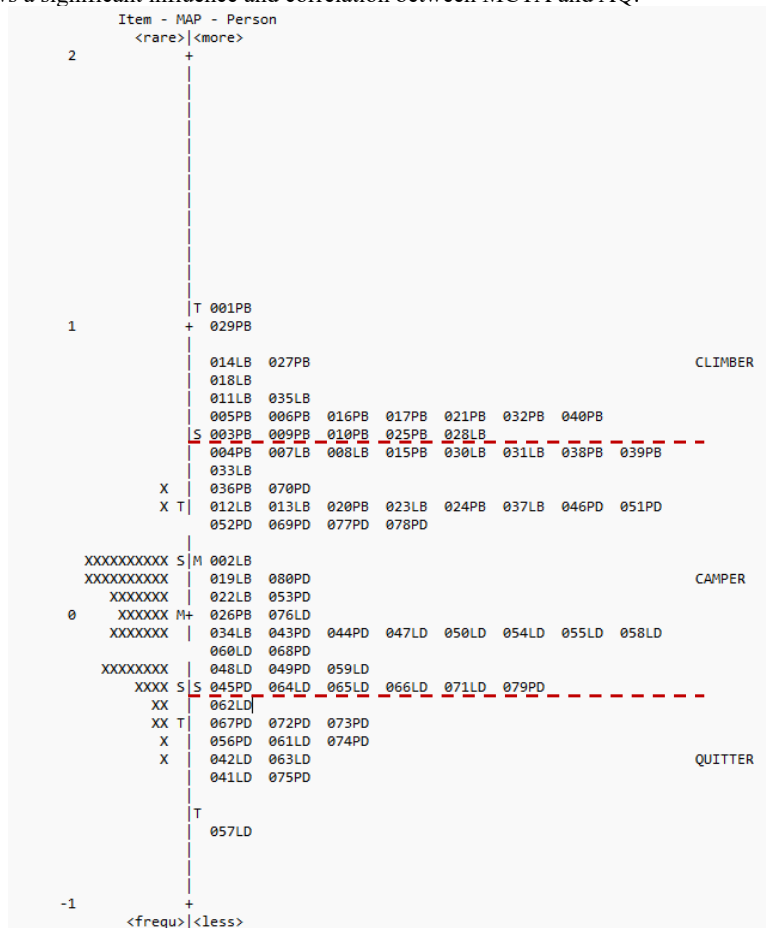


Figure 3. The wright maps on adversity quotient

Figure 3 shows the WinSteps data based on the Wright Maps table. Data came from 80 respondents who filled out the adversity quotient questionnaire and analyzed using WinSteps. Characteristics of respondents based on the type of camper, climber, and quitter shown in the right column are given a numerical code indicating the respondent's number and a letter code indicating gender and class. Meanwhile, the distribution of items (questionnaire items) is shown in the left column. The highest distribution of types is seen in the camper type with a respondent frequency of 49 respondents and the quitter type has the lowest distribution with a respondent frequency of 12 respondents. Camper-type students tend to be easily satisfied with what they receive even though they can produce more (Anggraini & Mahmudi, 2021). In fact, they prefer to be in a zone that they think is safe (Hastuti et al., 2018).

Table 7. Student's quantity based on wright maps AQ

Types of Adversity Quotient	Quantity
Climber	19
Camper	49
Quitter	12

Table 7 shows that from 80 students as respondents, there are 12 students who easily give up on facing challenges, in contrast to 19 students who really like challenges. The highest type distribution is in the camper type with 49 students. According to the percentage, there are 15% for quitter type students, 24% for climber type students, and 61% for camper type students.

Discussion

The results of the different tests in Table 4 between the control and experimental groups on Mathematical Critical Thinking Ability and AQ showed a significant difference, the control class was lower than the experimental class. Based on the research results that have been obtained, show that learning mathematics using GeoGebra software influences students' mathematical critical thinking skills. This can be seen through the average logit value score on the achievement of mathematical critical thinking skills of control group students with conventional learning treatment less than experimental group students with mathematics learning treatment using GeoGebra software ($0.057 < 1.211$). This is supported by the value of the Cohen's d Effect Size test which shows the effect in the large category (1.934). In line with the findings that state that learning with the help of GeoGebra software improves students' critical thinking skills compared to learning without the aid of GeoGebra software (Batubara, 2019).

Based on the results of the Spearman correlation test, it was obtained that the mathematical critical thinking ability (MCTA) and the adversity quotient (AQ) in the experimental class using GeoGebra-based learning showed a significant effect and correlation between the two ($r = 0.918$, $p < 0.05$) and the percentage was 91.8 %. This is based on the findings that result between AQ and critical thinking skills have a very strong relationship and influence (Rahayu & Alyani, 2020). The relationship between critical thinking skills and adversity quotient can be seen through the type of AQ categorized (Stoltz, 2000). In line with research that states that the achievement of thinking processes is influenced by the three levels in the adversity quotient, namely Climber, Camper, and Quitter (Yanti et al., 2018).

The findings of Asmar and Delyana (2020) state that learning by utilizing GeoGebra software shows the strength of the correlation between critical thinking and independent learning. The use of GeoGebra software is also able to improve student learning achievement (Alkhateeb & Al-Duwairi, 2019). This is supported by the finding that GeoGebra supports the construction of lines, points, or all conic sections, therefore this geometry software is dynamic (Birgin & Acar, 2020). Then Supriadi (2015) in his research said that those who used the GeoGebra interactive software had higher learning outcomes than those who did not use the GeoGebra software.

Based on the results of the Wright Maps AQ of students in the group treated with GeoGebra-assisted learning with students with conventional learning in Figure 3, it can be seen that the distribution of the highest student adversity quotient type is in the camper type with a percentage of 61%. Meanwhile, climber and quitter type students have a percentage of 24% and 15%, respectively. Through Wright Maps, it can also be seen that the adversity quotient of climber type students is dominated by students with learning using GeoGebra and the quitter type is dominated by students with conventional learning.

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Rahayu and Alyani (2020) stated that in their research the effect of Adversity Quotient on mathematical critical thinking skills was 75%, especially for the camper type. Wahyu Hidayat and Sari (2019) found that quitter students tend to find it difficult to solve existing problems and are classified as weak in critical thinking achievements. In several studies of the climber type, it was found that students with this type were able to persist in solving mathematical problems by fulfilling mathematical critical thinking indicators (Rahayu & Alyani, 2020). To find out the distribution of students' mathematical critical thinking skills with learning treatment using GeoGebra and conventional learning treatments, researchers divided the results of mathematical critical thinking skills that can be seen through three types of AQ taken from Table 6.

2. Dik: 1. lingkaran $1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 2. lingkaran $2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Dit: tentukan dan titik singgung kedua lingkaran
 Jawab: $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 4. The response of students with AQ quitter

Identification : Given the equation of the circle $1 = x^2 + y^2 - 12x - 12y + 36 = 0$ and
 Equation of circle $2 = x^2 + y^2 + 8x - 12y + 36 = 0$.
 Asked, the position and the point of tangency of the two circles?
 Analysis : $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 5. The process of MCTA of students with AQ quitter

Figures 4 and 5 show the results of students working with code 042LD with the quitter type who have difficulty completing the analysis stage. Students who are in the control class with conventional learning are only able to fulfill the identification and analysis indicators, however, the analysis indicators cannot complete completely. This indicates that students with the quitter type AQ are weak and give up easily in analyzing a problem which affects mathematical critical thinking skills (Brown et al., 2010; Wahyu Hidayat & Sari, 2019; Pangma et al., 2009; Rahayu & Alyani, 2020).

$L_1 : x^2 + y^2 - 12x - 12y + 36 = 0$	P6C
$L_2 : x^2 + y^2 + 8x - 12y + 36 = 0$	$(0+4)(x+4) + (6-6)(y-6) = 16$
$L_1 : (x-6)^2 + (y-6)^2 - 36 - 36 + 36 = 0$	$4(x+4) = 16$
$(x-6)^2 + (y-6)^2 = 36$	$x+4 = 4$
$P(6, 6)$	$x = 0$
$r = 6$	$= 4+4$
$L_2 : (x+4)^2 + (y-6)^2 - 16 - 36 + 36 = 0$	$(0-6)(x-6) + (6-6)(y-6) = 36$
$(x+4)^2 + (y-6)^2 = 16$	$-6(x-6) = 36$
$P(-4, 6)$	$x-6 = -6$
$r = 4$	$x = 0$
P6C dalam kedua lingkaran melalui titik (0, 6)	

Figure 6. The response of students with AQ camper

Identification : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Analysis : $L_1 = (x - 6)^2 + (y - 6)^2 - 36 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 36$
 $P(6,6)$
 $r = 6$
 $L_2 = (x - 4)^2 + (y - 6)^2 - 16 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 16$
 $P(-4,6)$
 $r = 4$
 Evaluation : Equation of tangent $(0 + 4)(x + 4) + (6 - 6)(y - 6) = 16$
 $4(x + 4) = 16$
 $x + 4 = 4$
 $x = 0$ or
 $(0 - 6)(x - 6) + (6 - 6)(y - 6) = 36$
 $-6(x - 6) = 36$
 $x - 6 = -6$
 $x = 0$
 The equation of the tangent to the two circles through the point $(0,6)$.

Figure 7. The process of MCTA of students with AQ camper

Figures 6 and 7 above show the results of students working with code 038PB with a camper type that can complete up to the evaluation stage. Students who are given a learning approach using GeoGebra software can meet the identification, analysis, and evaluation indicators, but not on the inferential indicators. In this evaluation indicator, students can determine the position of the two circles but it is not written down. This indicates that students with camper type AQ belong to the medium category (Wahyu Hidayat et al., 2018). This type is easily satisfied with what is being done and sometimes does not see the possibilities (Alyani & Zahra, 2020; Rahayu & Alyani, 2020).

Diketahui : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Ditanyakan : Tentukan kedua garis
 Diketahui : * $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(-12), -\frac{1}{2}(-12))$
 $= (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{6^2 + 6^2 - 36}$
 $= \sqrt{36 + 36 - 36}$
 $= \sqrt{72 - 36}$
 $= \sqrt{36} = 6$
 * $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(8), -\frac{1}{2}(-12))$
 $= (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{(-4)^2 + 6^2 - 36}$
 $= \sqrt{16 + 36 - 36}$
 $= \sqrt{52 - 36}$
 $= \sqrt{16} = 4$
 * Menentukan persamaan
 $AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2}$
 $= \sqrt{(-10)^2 + 0^2}$
 $= \sqrt{100} = 10$
 Jadi, persamaan kedua garis adalah $\frac{(y - 6) - 6(x - 6)}{10} = \frac{y - 6}{10} = \frac{x - 6}{10}$

Figure 8. The response of students with AQ climber

Identification : We know that $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ dan $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$. (Intersect at a point)
 Asked, position of the two lines.

Analysis : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $r_1 = \sqrt{6^2 + 6^2 - 36} = \sqrt{36 + 36 - 36} = \sqrt{36} = 6$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $r_2 = \sqrt{(-4)^2 + 6^2 - 36} = \sqrt{16 + 36 - 36} = \sqrt{16} = 4$

Evaluation : Determine position :
 $P_1P_2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2} = \sqrt{(-10)^2 + (0)^2} = \sqrt{100} = 10$

Inference : It is concluded that $P_1P_2 = r_1r_2 = 6 + 4 = 10$. So, the position of the two lines is an external tangent.

Figure 9. The process of MCTA of students with AQ climber

Figures 8 and 9 above show the results of students working with code 001PB with a climber type that can solve problems easily. Students who are given a learning approach using GeoGebra software can meet all indicators of identification, analysis, evaluation, and inference. In indicators of identification and analysis, students can understand the concept of the equation of a circle in determining the radius and center of the provided equation. So, on the evaluation indicators, the results obtained and the conclusions on the inference indicators can be written correctly. This indicates that students with climber type AQ can survive to find that the solution they get is right (Wahyu Hidayat & Sari, 2019; Oliveros, 2014; Phoolka & Kaur, 2012). This type is easily satisfied with what he can and does and sometimes ignores the possibilities obtained and belongs to the good AQ category (Alyani & Zahra, 2020). This is in line with the characteristics of the climber type AQ, which can use various solutions and has a persistent and courageous nature (Hidayah et al., 2016).

4. CONCLUSION

Learning mathematics using GeoGebra software has a significant effect on students' mathematical critical thinking skills, showing an influence in large categories and having a good relationship. Meanwhile, students are dominated by camper type AQ. Therefore, students with learn mathematics using GeoGebra software have better mathematical critical thinking skills than students with conventional mathematics learning. Based on the Wright Maps adversity quotient, climber-type students are dominated by students who study using GeoGebra. While the quitter type is dominated by students with conventional learning. This is supported by the results of field findings which show that students with learning using GeoGebra software are more active and enthusiastic in learning compared to students with conventional learning.

Based on the results of the research that has been done, teachers can apply learning using the GeoGebra application or other applications that can support learning. In the future, researchers can explore the media used in learning with more contrasting variables and subjects.

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Students' Mathematical Critical Thinking Using Geogebra Software Based on Adversity Quotient

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Abstrak

Kemampuan berpikir kritis tidak diimbangi dengan optimalnya pendekatan pembelajaran. Hal ini terlihat dari rendahnya capaian kemampuan berpikir kritis matematis. Penelitian ini ialah penelitian kuantitatif eksperimen yang memiliki tujuan mengetahui pengaruh pembelajaran menggunakan *software GeoGebra* terhadap kemampuan berpikir kritis matematis berdasarkan *adversity quotient* (AQ). Rancangan penelitian yang digunakan ialah *Posttest Only Control Group Design*. Populasi penelitian ini yaitu siswa SMA kelas XI pada salah satu sekolah di Jakarta dan sampel yaitu 40 siswa yang berasal dari kelas eksperimen dan 40 siswa berasal dari kelas kontrol dengan pembelajaran konvensional dan dipilih secara purposive. Instrumen tes didasarkan pada penilaian kemampuan kritis matematis dan non-tes berupa angket *adversity quotient*. Data kemudian dianalisis dengan *Mann Whitney U Test*, *Cohen's d Effect Size Test* dan *Spearman Correlation*. Hasil yang diperoleh dari pembelajaran matematika menggunakan *software GeoGebra* memiliki kemampuan berpikir kritis lebih baik dari siswa dengan pembelajaran matematika konvensional. Berdasarkan *Wright Maps*, *adversity quotient* siswa tipe *climber* didominasi oleh siswa dengan pembelajaran menggunakan *GeoGebra*. Sementara tipe *quitter* didominasi oleh siswa dengan pembelajaran konvensional. Kesimpulan penelitian ini, pembelajaran menggunakan *software GeoGebra* memiliki pengaruh terhadap kemampuan berpikir kritis matematis ditinjau dari *Adversity Quotient*.

Kata kunci: *Adversity Quotient*; Kemampuan Berpikir Kritis Matematis; *GeoGebra Software*

Abstract

The ability to think critically is not balanced with an optimal learning approach. This can be seen from the low achievement of mathematical critical thinking skills. This research is an experimental quantitative study that aims to determine the effect of learning using *GeoGebra* software on mathematical critical thinking skills based on the *adversity quotient* (AQ). The research design used was *Posttest Only Control Group Design*. The population of this research is high school students in class XI at one school in Jakarta and the sample is 40 students from the experimental class and 40 students from the control class with conventional learning and selected purposively. The test instrument is based on an assessment of critical mathematical abilities and a non-test in the form of an *adversity quotient* questionnaire. The data were then analyzed by *Mann Whitney U Test*, *Cohen's d Effect Size Test*, and *Spearman Correlation*. The results obtained from learning mathematics using *GeoGebra* software have better critical thinking skills than students with conventional mathematics learning. Based on *Wright Maps*, the *adversity quotient* of climber-type students is dominated by students who study using *GeoGebra*. While the quitter type is dominated by students with conventional learning. The conclusion of this study, learning using *GeoGebra* software has an influence on mathematical critical thinking skills in terms of *Adversity Quotient*.

Keywords: *Adversity Quotient*; Mathematical Critical Thinking Ability; *GeoGebra Software*

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1. INTRODUCTION

Mathematical critical thinking is the foundation of the thinking process in generating ideas, analyzing arguments, and developing a logical mindset (Dhayanti et al., 2018; Dockendorff & Solar, 2018; Wahyu Hidayat & Sari, 2019; Wechsler et al., 2018). The thought process in question is carried out, so that in learning not only remember and know the concept but to the stage of developing a mindset and applying it in a structured manner. For this, Batubara (2019) states that critical thinking is not only able to remember or know the

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concepts that have been studied but, in the process, can express again with other easy-to-understand concepts, interpret data and apply concepts based on structured logical thinking patterns.

Referring to the content standards contained in primary and secondary education units in mathematics subjects by teachers, among others, there are analytical, logical, creative, systematic, and critical thinking skills, that can work together (Asmar & Delyana, 2020). The re-application of mathematical critical thinking skills in the 2013 curriculum has the aim that, in learning, students will be able to start thinking critically (Wulandari, 2020). Because they need critical thinking skills to overcome their problems in life (Delina et al., 2018). Paul and Elder (2019) developed indicators of critical thinking skills which include the identification process, analysis of the results of identification, then evaluation, and finally the conclusion process. Based on this, critical thinking skills are important for students to have because they can develop a logical mindset, can think rationally, and apply them in dealing with problems in the learning process.

However, the importance of critical thinking skills is not accompanied by an optimal learning approach and one's initial abilities, so it influences studies related to the results of skills in mathematical critical thinking. This is based on the findings (W. Hidayat & Aripin, 2019) which state that the learning approach and initial abilities cannot meet the achievement of mathematical critical thinking skills. Not only initial abilities and approaches to learning mathematics are the determinants of success, but there is also an attitude factor in it. Mathematical critical thinking according to Rahayu and Alyani (2020) is an ability that demands being able to solve all the problems it is facing. To be able to fight through this challenge, the Adversity Quotient plays an important role in solving the problems in it.

Adversity Quotient (AQ) is a concept that was first put forward by Paul Stolz in measuring how hard a person's struggles and ability to solve problems is also one of the attitude factors that influence mathematical critical thinking skills in mathematics subjects (Rahayu & Alyani, 2020). This can be seen in Quitter's difficulty in solving existing problems and is classified as weak in critical thinking achievement, namely at an average score of 4.27 (Sari & Hidayat, 2019). Adversity quotient is divided into three types: Climber, Camper, and Quitter. In this initial type (Climber), whatever pressure a person faces will tend to be able to persist in solving the problems at hand. The second type (Campers) tend to be satisfied with what they get and don't want to take high risks. Then, in the third type (Quitters) a person tends not to want to try to be able to solve the problem, and gives up easily. So that the three types can also be used as indicators of a person facing difficulties (Wahyu Hidayat et al., 2018; Wulandari, 2020). Wahyu Hidayat & Sari (2019) stated that the adversity quotient plays a role in influencing the achievement of mathematical critical thinking skills. This is supported by research that reveals the effect of Adversity Quotient on mathematical critical thinking skills by 75%, especially for the camper type (Rahayu & Alyani, 2020). Through the ability to solve a challenge, one can train one's mathematical critical thinking skills (Supandi & Senam, 2020). So mathematical critical thinking skills are very important because they influence the Adversity Quotient aspect.

There have been several studies in recent years related to the adversity quotient, namely, Rahayu & Alyani (2020), Wahyu Hidayat & Sari (2019), Wahyu Hidayat et al. (2018), Yanti et al. (2018). Rahayu & Alyani (2020) discuss that the largest distribution of AQ type is in the camper type by 69.23%, and 75% of AQ has an influence on mathematical critical thinking ability while the rest comes from external factors. Wahyu Hidayat and Sari (2019) stated that the lowest achievement when solving questions was seen in the quitter type students and the highest in the camper type. Thus, the influence given by AQ on the achievement of critical thinking is good. Wahyu Hidayat et al. (2018) in their research found that AQ had a large effect on the argumentation ability of prospective teachers by 60.2% and other factors 39.8%.

Then Yanti et al. (2018) show that climber 1 students can fulfill all wallas indicators with moderate completeness, climber 2 students have difficulty on several indicators so climber 2 students have creative abilities in the medium category.

Developments and changing times require humans to be able to think critically, logically, creatively, take initiative and be adaptive to change (Yanti et al., 2018). This requires rapid technological developments with both positive and negative impacts on life, including in the world of education through learning media. Batubara (2019) stated that mathematical critical thinking skills increased with the help of learning media in the form of GeoGebra software compared to without GeoGebra software. GeoGebra is an open-source mathematical software program that can be accessed by anyone with an internet network. Not only that, this software is easy to use because it combines the features of calculus, algebra, and geometry, which supports the construction of lines, points, and all conic sections, so this geometry software is dynamic (Birgin & Acar, 2020; Dockendorff & Solar, 2018; Ishartono et al., 2022). GeoGebra has a menu that is presented complete with icons that are easy to understand to make learning more interactive (Rohaeti & Bernard, 2018; Yurniwati & Soleh, 2020). Alkhateeb and Al-Duwairi (2019), also said GeoGebra Software with features that make it easier for teachers and teachers to interact to solve math problems, has a positive influence and can deepen mathematical critical thinking. Thus, the gap in this study is the learning treatment using GeoGebra which was carried out in the experimental class. Thus, the gap in this study is the learning treatment using GeoGebra which was carried out in the experimental class.

Therefore, this study aims to elaborate mathematical critical thinking skills using GeoGebra software based on students' AQ. In this study, it will be seen whether there is an effect of learning mathematics using GeoGebra software on critical thinking skills in terms of AQ.

2. METHOD

In achieving the objectives of this study, the method used was experimental with posttest only control group design (Table 1) and a quantitative approach. To find out how the effect of mathematics learning treatment using GeoGebra software in the experimental group and conventional mathematics learning treatment in the control group on mathematical critical thinking ability (MCTA) based on the adversity quotient (AQ).

Table 1. Post-test only control group design

Category	Treatment	Post-test
Experimental Group	X_1	O_1
Control Group	X_2	O_2

Table 2 presents the post-test-only control group design where X_1 and X_2 are the treatments given, X_1 is the treatment in the experimental group by applying Mathematics learning using GeoGebra and X_2 is the treatment in the control group by applying conventional Mathematics learning. While O_1 and O_2 represent the experimental and control groups respectively. The population in this study were students who were at the high school level in the city of Jakarta. Meanwhile, as many as 80 samples of class XI students were selected purposively from four parallel classes where each class consisted of 40 students.

The approach in this research is quantitative in the form of the results of student learning abilities, therefore the instrument used is in the form of tests and non-tests that have been validated. The test instrument is based on students' MCTA (Mathematical Critical Thinking Ability), while the non-test instrument is in the form of an AQ (Adversity Quotient)

Statistics	Fit Indices
Point Measure Correlation (PTMEA-CORR)	0.4 – 0.85
Outfit Z-Standardized Values (ZSTD)	(-2.0) – (+2.0)
Outfit Mean Square Values (MNSQ)	0.5 – 1.5

Table 2. Fit indices

Statistics	Fit Indices
Point Measure Correlation (PTMEA-CORR)	0.4 – 0.85
Outfit Z-Standardized Values (ZSTD)	(-2.0) – (+2.0)
Outfit Mean Square Values (MNSQ)	0.5 – 1.5

The validation process is carried out by two expert validators and then tested on students to see validity and reliability. The results show that the average of all items on the test and non-test questions are valid and reliable with Cronbach's Alpha of 0.93 for the AQ instrument and 0.86 for the MCTA test questions in 208 students are in the very high category (Faradillah & Febriani, 2021). Thus, it can be used to be tested on students in the experimental group and the control group. For example, non-test and test instruments can be seen in Figures 1 and 2 below.

Seorang pedagang kaki lima sedang mengamati salah satu pengunjung taman yang sedang berlari pagi mengitari taman berbentuk lingkaran dengan jarak lintasan pengunjung tersebut terhadap pusat taman 6 m, sedangkan jarak pedagang terhadap pusat taman 12 m. Misalkan posisi tempat pedagang melihat sebagai titik koordinat dalam meter dan pusat lingkaran terdapat pada sumbu- x , tentukan persamaan lintasan pengunjung dan buatlah grafik persamaan lingkaran.

Figure 1. Test instrument on adversity quotient

Saya berpartisipasi mengikuti lomba olimpiade.

a. Penyebab saya berpartisipasi mengikuti lomba olimpiade adalah sesuatu yang :

Diluar kendali saya	1	2	3	4	5	Dibawah kendali saya
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C+

b. Penyebab saya berpartisipasi mengikuti lomba olimpiade dikarenakan:

Saya sendiri	1	2	3	4	5	orang lain atau faktor lain
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O₂ +

Figure 2. Test instrument on mathematical critical thinking ability

The data generated will go through an analysis process using the Mann Whitney U Test, Cohen's d Effect Size Test and Spearman Correlation to answer the research question, namely knowing the effect given by the GeoGebra-based Mathematics learning treatment in the experimental class with conventional learning in the control class. The decision-making criteria in the Effect Size Test use the interpretation presented in table 3 (Sawilowsky, 2009). Before the Cohen's d Effect Size test, Mann Whitney was first tested. The Mann Whitney test was conducted to determine whether or not there were differences in the data groups. The analysis of this hypothesis test was carried out through IBM SPSS 25.

Table 3. Estimated values of effect size

Estimated Values	Size of Effect
0 - 0.01	Very Small
0.01 - 0.2	Small

0.2 - 0.5	Medium
0.5 - 0.8	Large
0.8 - 1.2	Very Large
1.2 - 2.0	Huge

3. RESULT AND DISCUSSION

Result

Mann Whitney statistical test in the control and experimental groups using the logit value of the test results with the Rasch Model obtained on both AQ variables and mathematical critical thinking skills are presented in Table 4.

Table 4. Mann whitney test of mathematical critical thinking ability and AQ

		MCTA		AQ	
		Eksperiment	Control	Eksperiment	Control
N	Valid	40	40	40	40
	Missing	0	0	0	0
Median		0.99	0.01	0.56	-0.12
Mann-Whitney U		94.00		93.50	
Asymp. Sig. (2-tailed)		.000		.000	

Table 4 shows that the MCTA of students in the control class with a median = 0.01 is significantly lower than the experimental class student's median = 0.99. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. On the other hand, the adversity quotient of students in the control class with a median = -0.12 was significantly lower than that of the experimental class, median = 0.56. Then it is known that the value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates H1 is accepted. So that it shows that there is a significant difference between the control and experimental groups on students' MCTA and AQ.

Table 5. Effect size cohen's d test of experiment and control group toward MCTA and AQ

Aspect	Control Group		Experimental Group		
	Mean	SD	Mean	SD	d
MCTA	0.057	0.441	1.211	0.719	1.934
AQ	-0.125	0.275	0.533	0.256	2.519

Table 5 shows the Cohen's d Effect Size test value based on the logit value on Winstep. The results obtained that the experimental group on the adversity quotient aspect has the most significant effect size with a large effect of 2,519 and is in a large category. Furthermore, in the experimental group, the aspect of mathematical critical thinking ability (MCTA) has a d value of 1,934 which is also categorized as a large category.

Table 6. Spearman correlation test of MCTA and AQ

		MCTA	Adversity
MCTA (Mathematical Critical Thinking Ability)	Correlation Coefficient	1.000	0.918**
	Sig. (2-tailed)	.	0.001
	N	80	80
AQ (Adversity Quotient)	Correlation Coefficient	0.918**	1.000
	Sig. (2-tailed)	.001	.
	N	80	80

**Correlation is significant at the 0.01 level

Table 6 shows the results of the Spearman correlation test with the Logit value obtained between MCTA and AQ in the experimental class using GeoGebra-based learning of $0.001 < 0.05$. The correlation coefficient value of 0.918 with a percentage of 91.8% shows a very strong correlation between mathematical critical thinking skills and the adversity quotient. So it shows a significant influence and correlation between MCTA and AQ.

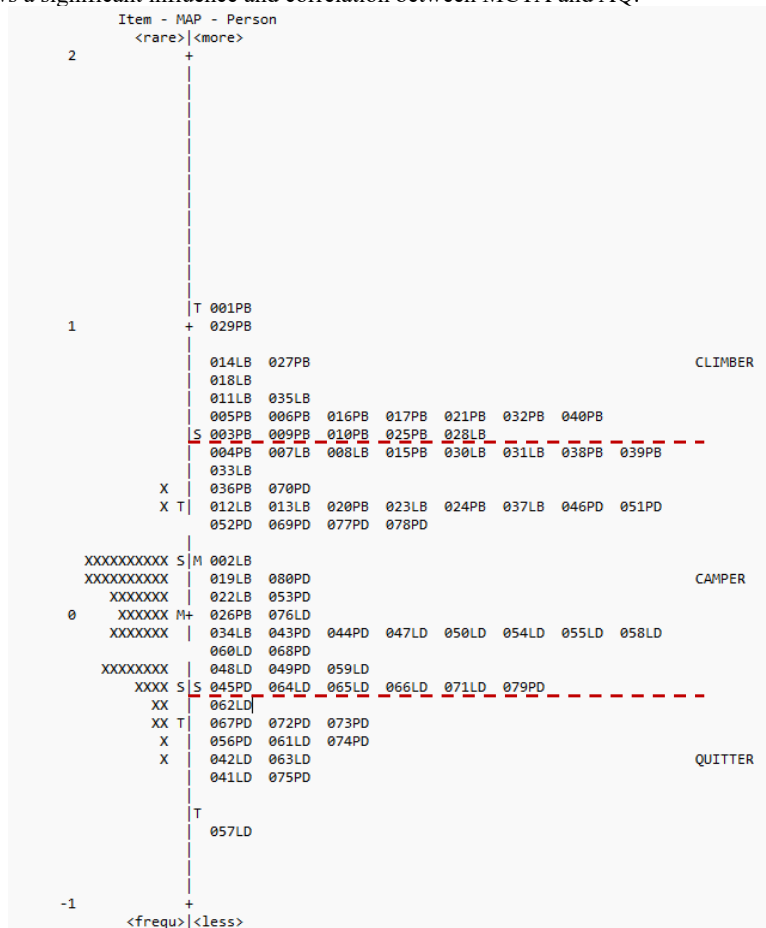


Figure 3. The wright maps on adversity quotient

Figure 3 shows the WinSteps data based on the Wright Maps table. Data came from 80 respondents who filled out the adversity quotient questionnaire and analyzed using WinSteps. Characteristics of respondents based on the type of camper, climber, and quitter shown in the right column are given a numerical code indicating the respondent's number and a letter code indicating gender and class. Meanwhile, the distribution of items (questionnaire items) is shown in the left column. The highest distribution of types is seen in the camper type with a respondent frequency of 49 respondents and the quitter type has the lowest distribution with a respondent frequency of 12 respondents. Camper-type students tend to be easily satisfied with what they receive even though they can produce more (Anggraini & Mahmudi, 2021). In fact, they prefer to be in a zone that they think is safe (Hastuti et al., 2018).

Table 7. Student's quantity based on wright maps AQ

Types of Adversity Quotient	Quantity
Climber	19
Camper	49
Quitter	12

Table 7 shows that from 80 students as respondents, there are 12 students who easily give up on facing challenges, in contrast to 19 students who really like challenges. The highest type distribution is in the camper type with 49 students. According to the percentage, there are 15% for quitter type students, 24% for climber type students, and 61% for camper type students.

Discussion

The results of the different tests in Table 4 between the control and experimental groups on Mathematical Critical Thinking Ability and AQ showed a significant difference, the control class was lower than the experimental class. Based on the research results that have been obtained, show that learning mathematics using GeoGebra software influences students' mathematical critical thinking skills. This can be seen through the average logit value score on the achievement of mathematical critical thinking skills of control group students with conventional learning treatment less than experimental group students with mathematics learning treatment using GeoGebra software ($0.057 < 1.211$). This is supported by the value of the Cohen's d Effect Size test which shows the effect in the large category (1.934). In line with the findings that state that learning with the help of GeoGebra software improves students' critical thinking skills compared to learning without the aid of GeoGebra software (Batubara, 2019).

Based on the results of the Spearman correlation test, it was obtained that the mathematical critical thinking ability (MCTA) and the adversity quotient (AQ) in the experimental class using GeoGebra-based learning showed a significant effect and correlation between the two ($r = 0.918$, $p < 0.05$) and the percentage was 91.8 %. This is based on the findings that result between AQ and critical thinking skills have a very strong relationship and influence (Rahayu & Alyani, 2020). The relationship between critical thinking skills and adversity quotient can be seen through the type of AQ categorized (Stoltz, 2000). In line with research that states that the achievement of thinking processes is influenced by the three levels in the adversity quotient, namely Climber, Camper, and Quitter (Yanti et al., 2018).

The findings of Asmar and Delyana (2020) state that learning by utilizing GeoGebra software shows the strength of the correlation between critical thinking and independent learning. The use of GeoGebra software is also able to improve student learning achievement (Alkhateeb & Al-Duwairi, 2019). This is supported by the finding that GeoGebra supports the construction of lines, points, or all conic sections, therefore this geometry software is dynamic (Birgin & Acar, 2020). Then Supriadi (2015) in his research said that those who used the GeoGebra interactive software had higher learning outcomes than those who did not use the GeoGebra software.

Based on the results of the Wright Maps AQ of students in the group treated with GeoGebra-assisted learning with students with conventional learning in Figure 3, it can be seen that the distribution of the highest student adversity quotient type is in the camper type with a percentage of 61%. Meanwhile, climber and quitter type students have a percentage of 24% and 15%, respectively. Through Wright Maps, it can also be seen that the adversity quotient of climber type students is dominated by students with learning using GeoGebra and the quitter type is dominated by students with conventional learning.

Commented [R2]: The discussion still needs to be elaborated. Discuss the research results, then relate them to previous relevant research. Review in more depth, whether the findings in line with this study or different. Explain in detail, and provide generalizations at the end of the discussion. This discussion also needs further study on research novelty, because this is not yet in the text. Novelty will be seen if the author conducts a comparative study of the results of this study with relevant research.

Rahayu and Alyani (2020) stated that in their research the effect of Adversity Quotient on mathematical critical thinking skills was 75%, especially for the camper type. Wahyu Hidayat and Sari (2019) found that quitter students tend to find it difficult to solve existing problems and are classified as weak in critical thinking achievements. In several studies of the climber type, it was found that students with this type were able to persist in solving mathematical problems by fulfilling mathematical critical thinking indicators (Rahayu & Alyani, 2020). To find out the distribution of students' mathematical critical thinking skills with learning treatment using GeoGebra and conventional learning treatments, researchers divided the results of mathematical critical thinking skills that can be seen through three types of AQ taken from Table 6.

2. Dik: 1. lingkaran $1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 2. lingkaran $2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Dit: tentukan dan titik singgung kedua lingkaran
 Jawab: $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 4. The response of students with AQ quitter

Identification : Given the equation of the circle $1 = x^2 + y^2 - 12x - 12y + 36 = 0$ and
 Equation of circle $2 = x^2 + y^2 + 8x - 12y + 36 = 0$.
 Asked, the position and the point of tangency of the two circles?
 Analysis : $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{\dots}$

Figure 5. The process of MCTA of students with AQ quitter

Figures 4 and 5 show the results of students working with code 042LD with the quitter type who have difficulty completing the analysis stage. Students who are in the control class with conventional learning are only able to fulfill the identification and analysis indicators, however, the analysis indicators cannot complete completely. This indicates that students with the quitter type AQ are weak and give up easily in analyzing a problem which affects mathematical critical thinking skills (Brown et al., 2010; Wahyu Hidayat & Sari, 2019; Pangma et al., 2009; Rahayu & Alyani, 2020).

$L_1 : x^2 + y^2 - 12x - 12y + 36 = 0$	P6C
$L_2 : x^2 + y^2 + 8x - 12y + 36 = 0$	$(0+4)(x+4) + (6-6)(y-6) = 16$
$L_1 : (x-6)^2 + (y-6)^2 - 36 - 36 + 36 = 0$	$4(x+4) = 16$
$(x-6)^2 + (y-6)^2 = 36$	$x+4 = 4$
$P(6, 6)$	$x = 0$
$r = 6$	$= 4+4$
$L_2 : (x+4)^2 + (y-6)^2 - 16 - 36 + 36 = 0$	$(0-6)(x-6) + (6-6)(y-6) = 36$
$(x+4)^2 + (y-6)^2 = 16$	$-6(x-6) = 36$
$P(-4, 6)$	$x-6 = -6$
$r = 4$	$x = 0$
P6C dalam kedua lingkaran melalui titik (0, 6)	

Figure 6. The response of students with AQ camper

Identification : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 Analysis : $L_1 = (x - 6)^2 + (y - 6)^2 - 36 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 36$
 $P(6,6)$
 $r = 6$
 $L_2 = (x - 4)^2 + (y - 6)^2 - 16 - 36 + 36 = 0$
 $L_1 = (x - 6)^2 + (y - 6)^2 = 16$
 $P(-4,6)$
 $r = 4$
 Evaluation : Equation of tangent $(0 + 4)(x + 4) + (6 - 6)(y - 6) = 16$
 $4(x + 4) = 16$
 $x + 4 = 4$
 $x = 0$ or
 $(0 - 6)(x - 6) + (6 - 6)(y - 6) = 36$
 $-6(x - 6) = 36$
 $x - 6 = -6$
 $x = 0$
 The equation of the tangent to the two circles through the point $(0,6)$.

Figure 7. The process of MCTA of students with AQ camper

Figures 6 and 7 above show the results of students working with code 038PB with a camper type that can complete up to the evaluation stage. Students who are given a learning approach using GeoGebra software can meet the identification, analysis, and evaluation indicators, but not on the inferential indicators. In this evaluation indicator, students can determine the position of the two circles but it is not written down. This indicates that students with camper type AQ belong to the medium category (Wahyu Hidayat et al., 2018). This type is easily satisfied with what is being done and sometimes does not see the possibilities (Alyani & Zahra, 2020; Rahayu & Alyani, 2020).

2. Diketahui : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ berpusatkan
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$ pada titik lain.
 Ditanyakan : Tentukan kedua garis.
 Diketahui : * $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(-12), -\frac{1}{2}(-12))$
 $= (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{6^2 + 6^2 - 36}$
 $= \sqrt{36 + 36 - 36}$
 $= \sqrt{72 - 36}$
 $= \sqrt{36} = 6$
 * $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = (-\frac{1}{2}A, -\frac{1}{2}B)$
 $= (-\frac{1}{2}(8), -\frac{1}{2}(-12))$
 $= (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $= \sqrt{(-4)^2 + 6^2 - 36}$
 $= \sqrt{16 + 36 - 36}$
 $= \sqrt{52 - 36}$
 $= \sqrt{16} = 4$
 * Menentukan persamaan
 $AB = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ disamping
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2}$ $AB = r_1 + r_2$
 $= \sqrt{(-10)^2 + 0^2}$ $10 = 6 + 4$
 $= \sqrt{100} = 10$
 Jadi, kedudukan kedua garis adalah berimpitan.

Figure 8. The response of students with AQ climber

Identification : We know that $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$ dan $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$. (Intersect at a point)
 Asked, position of the two lines.

Analysis : $L_1 = x^2 + y^2 - 12x - 12y + 36 = 0$
 $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6, 6)$
 $r_1 = \sqrt{x^2 + y^2 - C}$
 $r_1 = \sqrt{6^2 + 6^2 - 36} = \sqrt{36 + 36 - 36} = \sqrt{36} = 6$
 $L_2 = x^2 + y^2 + 8x - 12y + 36 = 0$
 $P_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4, 6)$
 $r_2 = \sqrt{x^2 + y^2 - C}$
 $r_2 = \sqrt{(-4)^2 + 6^2 - 36} = \sqrt{16 + 36 - 36} = \sqrt{16} = 4$

Evaluation : Determine position :
 $P_1P_2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
 $= \sqrt{(-4 - 6)^2 + (6 - 6)^2} = \sqrt{(-10)^2 + (0)^2} = \sqrt{100} = 10$

Inference : It is concluded that $P_1P_2 = r_1r_2 = 6 + 4 = 10$. So, the position of the two lines is an external tangent.

Figure 9. The process of MCTA of students with AQ climber

Figures 8 and 9 above show the results of students working with code 001PB with a climber type that can solve problems easily. Students who are given a learning approach using GeoGebra software can meet all indicators of identification, analysis, evaluation, and inference. In indicators of identification and analysis, students can understand the concept of the equation of a circle in determining the radius and center of the provided equation. So, on the evaluation indicators, the results obtained and the conclusions on the inference indicators can be written correctly. This indicates that students with climber type AQ can survive to find that the solution they get is right (Wahyu Hidayat & Sari, 2019; Oliveros, 2014; Phoolka & Kaur, 2012). This type is easily satisfied with what he can and does and sometimes ignores the possibilities obtained and belongs to the good AQ category (Alyani & Zahra, 2020). This is in line with the characteristics of the climber type AQ, which can use various solutions and has a persistent and courageous nature (Hidayah et al., 2016).

4. CONCLUSION

Learning mathematics using GeoGebra software has a significant effect on students' mathematical critical thinking skills, showing an influence in large categories and having a good relationship. Meanwhile, students are dominated by camper type AQ. Therefore, students with learn mathematics using GeoGebra software have better mathematical critical thinking skills than students with conventional mathematics learning. Based on the Wright Maps adversity quotient, climber-type students are dominated by students who study using GeoGebra. While the quitter type is dominated by students with conventional learning. This is supported by the results of field findings which show that students with learning using GeoGebra software are more active and enthusiastic in learning compared to students with conventional learning.

Based on the results of the research that has been done, teachers can apply learning using the GeoGebra application or other applications that can support learning. In the future, researchers can explore the media used in learning with more contrasting variables and subjects.

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4. Bukti Konfirmasi Artikel *Accepted* (28 September 2022)



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[JPP] Editor Decision

2 messages

Ejournal Undiksha <ejournal@undiksha.ac.id>

Wed, Sep 28, 2022 at 4:06 PM

To: Fitri Alyani <fitrialyani@uhamka.ac.id>, Natalia Sartika <nata.dspr@gmail.com>

Fitri Alyani, Natalia Sartika:

We have reached a decision regarding your submission to Jurnal Pendidikan dan Pengajaran, "The Effect of Learning Using Geogebra Software on Mathematical Critical Thinking Ability Based on Adversity Quotient".

Our decision is to: Accepted Submission

Dear Author

Based on the results of the review, the manuscript was declared accepted, informed that the publishing fee was Rp. 1.500.000.00

Transfer of publishing fees to BRI Account No. 008801051612501 an. I Gusti Ayu Agung Manik W.

Then confirm with Mrs. Komang Meli Martini WA: 085941326324 By mentioning the author's name, journal name, article ID number, and proof of screenshot Accepted.

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Fitri Alyani <fitrialyani@uhamka.ac.id>

Thu, Sep 29, 2022 at 8:59 AM

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thank you for the announcement. I would ask if this article will be included in the October 2022 volume?

Thank you.

Regards,

Fitri Alyani

[Quoted text hidden]

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