**JURNAL PENDIDIKAN DAN PENGAJARAN**
Volume 55 Nomor 3 2022, 562-575
*E-ISSN: 2549-2608; P-ISSN: 2301-7821*
*DOI: https://doi.org/10.23887/jpp.v55i3.47491*

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

**Fitri Alyani[1*], Natalia Dinda Sartika Putri[2]**

[1,2] Department of Mathematics Education, University of Muhammadiyah Prof.DR.Hamka, Jakarta, Indonesia
*Corresponding author: fitrialyani@uhamka.ac.id

## *Abstract*

*Kemampuan berpikir kritis tidak seimbang dengan pendekatan pembelajaran yang optimal melalui capaian kemampuan berpikir kritis matematis (KBKM) yang rendah. Penelitian eksperimen semu dengan pendekatan kuantitatif digunakan untuk mengelaborasi pembelajaran menggunakan software GeoGebra kelas eksperimen dan kelas kontrol terhadap KBKM ditinjau dari adversity quotient (AQ). Siswa SMA kelas XI pada salah satu sekolah di Jakarta sebagai populasi penelitian dengan sampel 40 siswa kelas eksperimen dan 40 siswa kelas kontrol dan dipilih secara purposive. Instrumen tes didasarkan pada penilaian kemampuan berpikir kritis matematis dan angket adversity quotient. Data kemudian dianalisis dengan Mann Whitney U Test, Spearman Correlation dan Cohen's d Effect Size. Hasil menunjukan kemampuan berpikir kritis matematis kelas eksperimen lebih baik dari kelas kontrol. Berdasarkan Wright Maps, AQ siswa tipe climber didominasi oleh siswa kelas eksperimen, sementara siswa kelas kontrol mendominasi tipe quitter. Kesimpulan penelitian ini, terdapat perbedaan kemampuan berpikir kritis matematis kelas eksperimen menggunakan software GeoGebra dengan kelas kontrol ditinjau dari AQ.*

***Keywords:*** *Adversity Quotient; Kemampuan Berpikir Kritis Matematis; GeoGebra Sofware.*

## Abstract

The ability to think critically is not balanced with the optimal learning approach, to the low achievement of mathematical critical thinking ability (MCTA). Quasi-experimental research with a quantitative approach was used to determine the differences in learning using GeoGebra software for the experimental and the control class on MCTA in terms of adversity quotient (AQ). Class XI high school students in one of the schools in Jakarta as the research population, with sample students of 40 from the experimental class and 40 from the control class selected purposively. The instrument is based on an assessment of MCTA and an AQ questionnaire. The Mann-Whitney U Test, Spearman Correlation, and Cohen's d Effect Size were used to analyze the data. The results show the experimental class's MCTA is better than the control class. Based on Wright Maps, the AQ of climber-type students is dominated by the experiment class, while the control class dominates the quitter. The conclusion of this study, there are differences in the MCTA of the experimental class using GeoGebra software and the control class in terms of AQ.

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

**History:**
Received : May 24, 2022
Revised : May 28, 2022
Accepted : September 13, 2022
Published : October 25, 2022

**Publisher:** Undiksha Press


## 1. INTRODUCTION

The reapplication of mathematical critical thinking ability (MCTA) in the 2013 curriculum has the aim of students learning to be able to start thinking critically (Wulandari, 2020). Because with the critical thinking ability possessed by students, students will be able to think rationally and apply it to their mathematical abilities. Paul and Elder developed MCTA indicators, which include the identification process, analysis of the results of identification, evaluation, and finally the inference process (Paul & Elder, 2019). Mathematical critical thinking is the cornerstone of the thought process in generating ideas, analyzing arguments, and developing a logical mindset (Dhayanti et al., 2018; Hidayat & Sari, 2019; Wechsler et al., 2018). The thought process in question is carried out so that in learning, not only do you remember and know concepts but also develop a mindset and apply them in a structured manner. Therefore, in critical thinking, students can not only remember

or know the concepts that have been learned but, in the process, they can re-express critical thinking with other concepts that are easy to understand, interpret data, and apply concepts based on a structured logical mindset (Antara et al., 2020; Batubara, 2019). Based on the results of a researcher's interview (March 07, 2022) with one of the mathematics teachers at the research site, most students had difficulty describing the graph of a quadratic equation and rarely applied software-based learning media. Then the lack of understanding of the MCTA concept can be seen in the difficulty of students in identifying and analyzing quadratic equation problems and integrating them into a graph form to make it easy to give up on solving mathematical problems. Based on these problems, the use of learning media is very important, especially for the mathematics material studied, which requires students to be able to integrate an equation in the form of a graph. So, learning GeoGebra software is needed for students to understand mathematical concepts easily.

GeoGebra is an open-source math software that anyone with an internet connection can use. supports the learners' initial conjectures and evaluates solutions differently (Hernández et al., 2020). Other than that, this open-source software is easy to use because it combines the features of calculus, algebra, and geometry, which supports the construction of lines, points, and all conical cross-sections, so this geometry software is dynamic (Birgin & Acar, 2020; Dockendorff & Solar, 2018; Ishartono et al., 2022; Soheila & Rosemaliza, 2018). It has a menu that is presented complete with icons that are easy to understand to make learning more interactive and can turn functions into chart functions (Maulyda et al., 2019; Rohaeti & Bernard, 2018; Yurniwati & Soleh, 2020). GeoGebra Software also has features that make it easier for teachers and students to visualize and demonstrate various activities so that they have a positive effect and can deepen the mathematical critical thinking of students (Alkhateeb & Al-Duwairi, 2019; Syafitri et al., 2018). MCTA increased with the help of learning media in the form of GeoGebra software compared to without GeoGebra software (Batubara, 2019). This is in line with the results of research that shows that the PBL approach to learning is no better than GeoGebra-based RME learning (Puspitasari et al., 2016). MCTA can also be reviewed through the fighting power of students in overcoming the problems in their lives of (Delina et al., 2018).

To find out how much the fighting power of students in solving problems can be known through the Adversity Quotient. The Adversity Quotient (AQ) is a concept first proposed by Paul Stolz to measure how hard a person struggles and their ability to solve problems is one of the attitude factors that influence MCTA in mathematics subjects (Rahayu & Alyani, 2020). This can be seen in the difficulty of Quitter-type students in solving mathematical problems, and they are classified as weak in achieving critical thinking, namely at an average score of 4.27 (Hidayat & Sari, 2019). The adversity quotient is divided into three types: climbers, campers, and quitters. In this initial type (Climber), whatever pressure a person faces will tend to be able to survive in solving the problem at hand. The second type (campers) tends to be satisfied with what is obtained and does not want to take high risks (Purwasih, 2020). 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 (Suryaningrum et al., 2020). So, these three types can also be used as indicators of a person facing difficulties (Hidayat et al., 2018; Wulandari, 2020). Through the ability to face a challenge, one can train one's MCTA (Supandi & Senam, 2020). So MCTA is very important because it affects the adversity quotient aspect. There have been several studies in recent years related to mathematical critical thinking ability (MCTA) (Chasanah, 2019; Dhayanti et al., 2018; Dolapcioglu & Doğanay, 2020; Hidayat & Sari, 2019; Rahayu & Alyani, 2020). AQ has an influence on MCTA and a significant relationship between critical thinking ability and AQ (Rahayu & Alyani, 2020). The lowest achievement in solving the problem was seen in quitter-type students and the highest in camper-type students. Thus, the influence that AQ exerts on the

achievement of critical thinking is good (Hidayat & Sari, 2019). Then, the implementation of RME with Geometer's Sketchpad material proportions was able to improve the creative thinking and critical thinking abilities of students (Dhayanti et al., 2018). Critical thinking ability can be improved through practice based on authentic learning standards (Dolapcioglu & Doğanay, 2020). 16.67% of students correctly conclude, and not all students correctly conclude (Chasanah, 2019). Unfortunately, to be able to answer the problems that have been presented and through research in recent years related to MCTA, there has been no research using GeoGebra software tools on MCTA reviewed through AQ.

Thus, the gap in this study is the treatment of mathematics learning using GeoGebra, which was carried out in an experimental class. Therefore, this study aims to elaborate on mathematical critical thinking ability using GeoGebra software based on learners' AQ. In this study, it will be seen whether there are differences in mathematics learning using GeoGebra software with conventional learning on critical thinking ability in terms of AQ.

## 2. METHODS

A quantitative approach was used in this study, with a quasi-experimental type of research. Meanwhile, the study design used a posttest-only control group in Table 1. To find out whether there are differences in the treatment of mathematics learning using GeoGebra software in the experimental group and the treatment of conventional mathematics learning in the control group on mathematical critical thinking ability (MCTA) based on adversity quotient (AQ).

**Table 1.** Post-test Only Control Group Design

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

(Krishnan, 2018)

The population in this study were students of class XI, one of the high schools in the East Jakarta area. A total of 80 samples of class XI MIPA students were selected purposively from four parallel classes, where each class consisted of 40 students. The purposive sampling technique was chosen because the criteria present in the entire sample did not fully correspond to the research phenomenon. Table 1 presents the design of the post-test-only control group 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 experimental and control groups, respectively.

The approach in this study is quantitative in the form of student learning ability results, therefore the instruments used are in the form of tests and non-tests that have been validated. The test instrument is 4 MCTA (Mathematical Critical Thinking Ability) questions of valid circle equation material. The instrument is in the form of an AQ (Adversity Quotient) questionnaire containing 20 positive statements and 40 negative statements with a Likert scale of 5 and adapted from (Alyani & Zahra, 2020). The scale consists of 5 "strongly agree," 4 "agree," 3 "neutral," 2 "disagree," and 1 "strongly disagree,". Table 2 shows the distribution of 60 positive and negative statement items spread out by dimensions in AQ.

**Table 2.** The Distribution of 60 Positive and Negative Statement Items of AQ

| Dimension | Number of Items | |
|---|---|---|
| | Positive | Negative |
| Control | 19, 25, 33, 45, and 53 | 1, 11, 15, 17, 31, 35, 37, 51, 55, and 57 |
| Origin and Ownership | 20, 26, 34, 46, and 54 | 2, 12, 16, 18, 32, 36, 38, 52, 56, and 58 |
| Reach | 5, 9, 39, 49, and 59 | 3, 7, 13, 21, 23, 27, 29, 41, 43, and 47 |
| Endurance | 6, 10, 40, 50, and 60 | 4, 8, 14, 22, 24, 28, 30, 42, 44, and 48 |

The validity and reliability of the two instruments were carried out using the Rasch Model in Table 3. Rasch's model is used because it can measure on a logit scale, display the right maps, view student distributions, and predict biases in missing data and dates (Ölmez & Ölmez, 2019).

**Table 3.** 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 |

(Sumintono & Widhiarso, 2014)

The validation process is carried out by two expert validators and then tested on students to see the validity and reliability of the item. The results showed that the average of all items on the test and non-test questions were valid and reliable with an Alpha Cronbach of 0.93 for AQ instruments and 0.86 for MCTA test questions in 208 students and was in a very high category (Faradillah & Febriani, 2021). MCTA posttests were selected as 3, 4, 5, and 7 were selected as MCTA posttests, while AQ items selected as many as 60 fit items as posttests. Thus, it can be used to test students in experimental groups and control groups. Following a posttest with MCTA instruments and AQ questionnaires that were valid in both the control and experimental classes, the data was converted into a ratio scale in the form of logit values (measure) using the Rasch Model Winsteps. The ratio scale with a higher degree of accuracy than the ordinal scale refers to this probability principle can be done with the Rasch Model (Muntazhimah et al., 2020). The resulting logit value data will go through an analysis process using Spearman Correlation, Mann Whitney U Test, and Effect Size Cohen's d Test to answer research questions, namely knowing whether there are differences in learning outcomes given by GeoGebra-based mathematics learning treatment in experimental classes compared with conventional learning in control classes. The decision-making criteria in the Effect Size Test use the interpretations presented in Table 4.

**Table 4.** 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 |

(Sawilowsky, 2009)

Before the Cohen's d Effect Size test, Mann Whitney was first tested. The Mann-Whitney test was performed to determine whether or not there were differences in the data group. Meanwhile, the Spearman Correlation test is carried out to determine the relationship between variables. This hypothesis test analysis was carried out through IBM SPSS 25. Through SPSS, researchers can see statistics in the form of mean, min, max, median, and standard deviations needed in research (Wahyuni, 2020).

## 3. RESULTS AND DISCUSSION

### Result

This 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 5.

**Table 5.** 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) | | 0.000 | | 0.000 | |

Table 5 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 *p*-value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates reject $H_0$. 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 *p*-value of Asymp.Sig. (2-tailed) = 0.001 which is below = 0.05 which indicates reject $H_0$. So that it shows that there is a significant difference between the control and experimental groups on students' MCTA and AQ.

**Table 6.** Effect Size Cohen's d Test Results

| **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 6 shows the Cohen's d Effect Size test value based on the logit value on Winsteps. 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 "very 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 "very large" category.

Table 7 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.

**Table 7.** 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

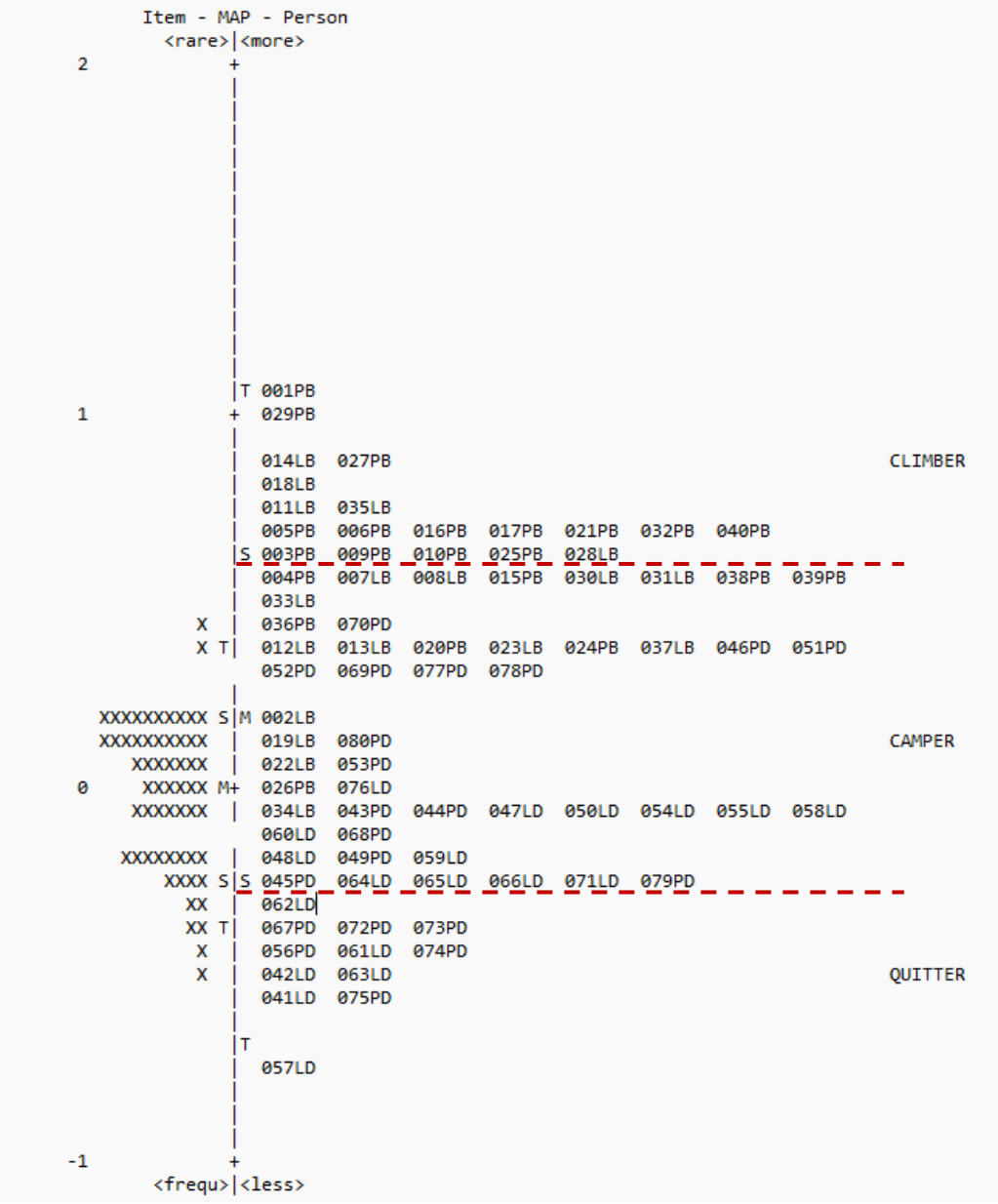


**Figure 1.** The Wright Maps on Adversity Quotient

Figure 1 shows the Winsteps data based on the Wright Maps table. Data were collected 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). They prefer to be in a zone that they think is safe (Hastuti et al., 2018).

**Table 8.** Student's Quantity Based on Wright Maps AQ

| Types of Adversity Quotient | Quantity |
|---|---|
| Climber | 19 |
| Camper | 49 |
| Quitter | 12 |

Table 8 shows that of 80 students as respondents, 12 students easily give up on facing challenges, in contrast to 19 students who 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. Figure 2 and Figure 3 show the results of students working with code 042LD with the quitter type who have difficulty completing the analysis stage.

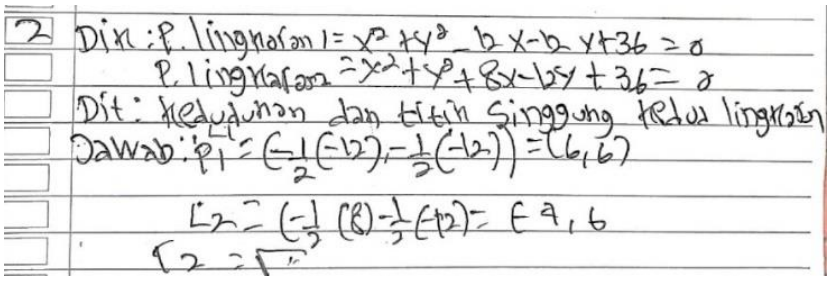

**Figure 2**. The Response of Students with AQ Quitter

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 : $P_1 = \left(-\frac{1}{2}(-12), -\frac{1}{2}(-12)\right) = (6,6)$

$L_2 = \left(-\frac{1}{2}(8), -\frac{1}{2}(-12)\right) = (-4,6)$

$r_2 = \sqrt{...}$

**Figure 3**. The Process of MCTA of Students with AQ Quitter

Figure 4 and Figure 5 shows the results of students working with code 038PB with a camper type that can complete up to the evaluation stage.

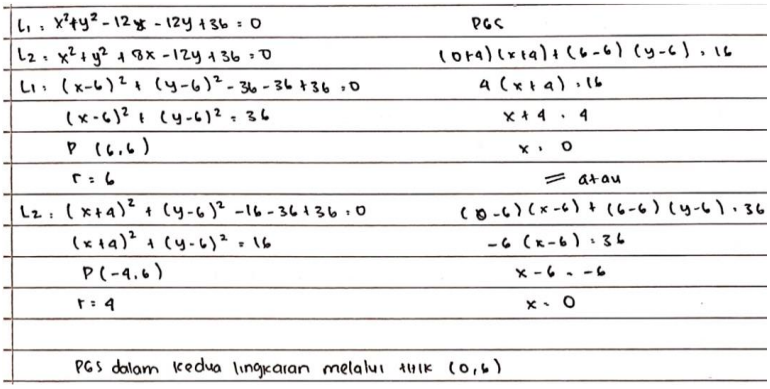


**Figure 4**. The Response of Students with AQ Camper

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 5**. The Process of MCTA of Students with AQ Camper

Figure 6 and Figure 7 show the results of students working with code 001PB with a climber type that can solve problems easily.

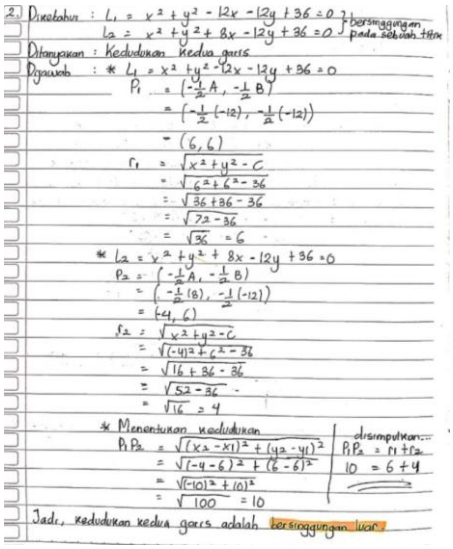


**Figure 6**. The Response of Students with AQ Climber

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 :*

$P_1P_2 = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

$= \sqrt{(-4 - 6)^2 + (6 - 6)^2} = \sqrt{(-10)^2 + (10)^2} = \sqrt{100} = 10$

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 7**. The Process of MCTA of Students with AQ Climber

## Discussions

The results of the hypothesis test were conducted with the Mann-Whitney test to determine the difference between the experimental class and GeoGebra and the control class. Cohen's d Effect Size test to determine the magnitude of influence by category (Sawilowsky, 2009). Then the Spearman correlation test to find out whether there is a relationship between MCTA and AQ. Through the Mann-Whitney U test in Table 5 between the control group and the experiment on MCTA, a *p*-value of 0.001 < 0.05 was obtained, indicating that there was a significant difference between the GeoGebra-based experimental group and the control group. Then, Mann-Whitney U on AQ obtained a *p*-value of 0.001 < 0.05 so there was a significant difference between the GeoGebra-based experimental group and the control group. The results of the Mann-Whitney U Test in the research that has been obtained show that there are significant differences in experimental classes through mathematics learning using GeoGebra software with control classes on student MCTA and student AQ. Not only were significant differences obtained, but in this differential test, the experimental group had a higher median compared to the control group in the different tests. Based on the results of the Effect Size Cohen's d test in Table 6, the average score of the MCTA logit score of students with a d score of 1.934. The magnitude of the effect on Cohen's d Effect Size test showed MCTA in the "very large" category. Then the results of the effect size Cohen's d test went through the average student's AQ logit score with a d score of 2.519. The magnitude of the effect on Cohen's d Effect Size test showed AQ in the "very large" category. In line with the findings stating that learning with the help of GeoGebra software increases the MCTA of students compared to learning without the help of GeoGebra software (Batubara, 2019).

Based on the results of the Spearman correlation test in Table 7, it was found 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 the results 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 of the adversity quotient, namely Climber, Camper, and Quitter (Yanti et al., 2018). 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 1, 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.

Previous studies show that the effect of Adversity Quotient on mathematical critical thinking skills was 75%, especially for the camper type (Rahayu & Alyani, 2020). Quitter students tend to find it difficult to solve existing problems and are classified as weak in critical thinking achievements (Hidayat & Sari, 2019). 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 8. Figure 2 and Figure 3 shows that 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; Hidayat & Sari, 2019; Pangma et al., 2009; Rahayu & Alyani, 2020). Figure 4 and Figure 5 show that students who are given a learning approach using GeoGebra software can meet the identification, analysis, and evaluation indicators, but not 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 (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).

Figure 6 and Figure 7 shows that 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 (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).

The findings of the previous MCTA study showed that AQ and MCTA on the lineup and series material had a significant relationship, and AQ showed a positive influence on student MCTA (Rahayu & Alyani, 2020). Another study found a significant relationship between learning independence and MCTA students using GeoGebra software by 0.412 (Asmar & Delyana, 2020). Then AQ has an influence on students' MCTA by 61% while 39% comes from outside. The novelty of this study is found in the learning variables using GeoGebra software, which were carried out in the control class on MCTA based on student AQ, so this study is a generalization of the previous research. It didn't stop there in this study. The Mann-Whitney U non-parametric statistical test and the Pearson correlation test were used to determine whether there were differences between the GeoGebra software-based experimental group and the control group in the circle equation material. Then the magnitude of the effect is in the "very large" category of both MCTA and AQ. Furthermore, a review was carried out based on the AQ categories of the camper, quitter, and climber types. This research also has an urgency so that in the future, teachers know the influence of mathematics learning using GeoGebra software on MCTA in terms of AQ.

## 4. CONCLUSION

Based on the results obtained, there are significant differences in mathematics learning using GeoGebra software in the mathematical critical thinking ability of experimental class students compared with conventional method control classes. The camper type dominates students. On Wright Maps, it can also be seen that the AQ of climber-type students is dominated by students with learning using GeoGebra. While the quitter type is dominated by students with conventional learning. Therefore, students with mathematics learning using GeoGebra software have better mathematical critical thinking ability than students with conventional mathematics learning. This is supported by field findings that show that students learning using GeoGebra software are more active and enthusiastic in their learning compared to students with conventional learning. Based on the results of research that has been carried out, researchers hope that teachers can apply to learn using the GeoGebra application or other applications that can support learning. In the future, other researchers can explore the media used in learning with more contrasting variables and subjects.

## 5. REFERENCES

Alkhateeb, M. A., & Al-Duwairi, A. M. (2019). The Effect of Using Mobile Applications (GeoGebra and Sketchpad) on the Students' Achievement. *International Electronic Journal of Mathematics Education*, *14*(3), 523–533. https://doi.org/10.29333/iejme/5754.

Alyani, F., & Zahra, R. (2020). Penerapan Rasch Model: Analisis Adversity Quotient Siswa dalam Matematika. *Math Didactic: Jurnal Pendidikan Matematika*, *6*(2), 226–234. https://doi.org/https://doi.org/10.33654/math.v6i2.102.

Anggraini, T. W., & Mahmudi, A. (2021). Exploring The Students' Adversity Quotient in Online Mathematics Learning During The Covid-19 Pandemic. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *6*(3), 221–238. https://doi.org/10.23917/jramathedu.v6i3.13617.

Antara, I. G. W. S., Sudarma, I. K., & Dibia, I. K. (2020). The Assessment Instrument of Mathematics Learning Outcomes Based on HOTS Toward Two-Dimensional Geometry Topic. *Indonesian Journal Of Educational Research and Review*, *3*(2), 19–24. https://doi.org/10.23887/ijerr.v3i2.25869.

Asmar, A., & Delyana, H. (2020). Hubungan Kemandirian Belajar Terhadap Kemampuan Berpikir Kritis Melalui Penggunaan Software Geogebra. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(2), 221–230. https://doi.org/10.24127/ajpm.v9i2.2758.

Batubara, I. H. (2019). Improving Student's Critical Thinking Ability Through Guided Discovery Learning Methods Assisted by Geogebra. *International Journal for Educational and Vocational Studies*, *1*(2), 116–119. https://doi.org/10.29103/ijevs.v1i2.1371.

Birgin, O., & Acar, H. (2020). The Effect of Computer-Supported Collaborative Learning Using GeoGebra Software on 11th Grade Students' Mathematics Achievement in Exponential and Logarithmic Functions. *International Journal of Mathematical Education in Science and Technology*, *0*(0), 1–18. https://doi.org/10.1080/0020739X.2020.1788186.

Brown, N. J. S., Furtak, E. M., Timms, M., Nagashima, S. O., & Wilson, M. (2010). The Evidence-Based Reasoning Framework: Assessing Scientific Reasoning. *Educational Assessment*, *15*(3), 123–141. https://doi.org/10.1080/10627197.2010.530551.

Chasanah, A. N. (2019). Cognitive Growth Learning Model to Improve the Students' Critical

Thinking Skills. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *4*(2), 112–123. https://doi.org/10.23917/jramathedu.v4i2.8127.

Delina, D., Afrilianto, M., & Rohaeti, E. E. (2018). Kemampuan Berpikir Kritis Matematis dan Self Confidence Siswa SMP Melalui Pendekatan Realistic Mathematic Education. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, *1*(3), 281. https://doi.org/10.22460/jpmi.v1i3.p281-288.

Dhayanti, D., Johar, R., & Zubainur, C. M. (2018). Improving Students' Critical and Creative Thinking Through Realistic Mathematics Education using Geometer's Sketchpad. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *3*(1), 25. https://doi.org/10.23917/jramathedu.v3i1.5618.

Dockendorff, M., & Solar, H. (2018). ICT integration in mathematics initial teacher training and its impact on visualization: the case of GeoGebra. *International Journal of Mathematical Education in Science and Technology*, *49*(1), 66–84. https://doi.org/10.1080/0020739X.2017.1341060.

Dolapcioglu, S., & Doğanay, A. (2020). Development of critical thinking in mathematics classes via authentic learning: an action research. *International Journal of Mathematical Education in Science and Technology*. https://doi.org/10.1080/0020739X.2020.1819573.

Faradillah, A., & Febriani, L. (2021). Mathematical Trauma Students' Junior High School Based on Grade and Gender. *Infinity Journal*, *10*(1), 53. https://doi.org/10.22460/infinity.v10i1.p53-68.

Hastuti, T. D., Sari, D. R., & Riyadi. (2018). Student Profile with High Adversity Quotient in Math Learning. *Journal of Physics: Conference Series*, *983*(1). https://doi.org/10.1088/1742-6596/983/1/012131.

Hernández, A., Perdomo-Díaz, J., & Camacho-Machín, M. (2020). Mathematical understanding in problem solving with GeoGebra: a case study in initial teacher education. *International Journal of Mathematical Education in Science and Technology*, *51*(2), 208–223. https://doi.org/10.1080/0020739X.2019.1587022.

Hidayah, S. R., Trapsilasiwi, D., & Setiawani, S. (2016). Proses Berpikir Kritis Siswa Kelas VII F Mts. Al-Qodiri 1 Jember dalam Pemecahan Masalah Matematika Pokok Bahasan Segitiga dan Segi Empat ditinjau dari Adversity Quotient. *Jurnal Edukasi*, *3*(3), 21. https://doi.org/10.19184/jukasi.v3i3.3517.

Hidayat, W., & Sari, V. T. A. (2019). Kemampuan Berpikir Kritis Matematis dan Adversity Quotient Siswa SMP. *Jurnal Elemen*, *5*(2), 242. https://doi.org/10.29408/jel.v5i2.1454.

Hidayat, W., Wahyudin, & Prabawanto, S. (2018). The Mathematical Argumentation Ability and Adversity Quotient (AQ) of Pre-service Mathematics Teacher. *Journal on Mathematics Education*, *9*(2), 239–248. https://doi.org/10.22342/jme.9.2.5385.239-248.

Ishartono, N., Nurcahyo, A., Waluyo, M., Prayitno, H. J., & Hanifah, M. (2022). Integrating GeoGebra into The Flipped Learning Approach to Improve Students' Self-Regulated Learning During The Covid-19 Pandemic. *Journal on Mathematics Education*, *13*(1), 69–86. https://doi.org/10.22342/jme.v13i1.pp69-86.

Krishnan, P. (2018). A review of the non-equivalent control group post-test-only design. *Nurse Reasearcher*, *26*(2), 37–40. https://doi.org/10.7748/nr.2018.e1582.

Maulyda, M. A., Hidayanto, E., & Rahardjo, S. (2019). Representation of Trigonometry Graph Function Colage Students Using GeoGebra. *International Journal of Trends in Mathematics Education Research*, *2*(4), 193–196. https://doi.org/10.33122/ijtmer.v2i4.

Muntazhimah, Putri, S., & Khusna, H. (2020). Rasch Model untuk Memvalidasi Instrumen

Resiliensi Matematis Mahasiswa Calon Guru Matematika. *JKPM (Jurnal Kajian Pendidikan Matematika)*, *6*(1), 65. https://doi.org/10.30998/jkpm.v6i1.8144.

Oliveros, J. C. (2014). Adversity Quotient and Problem-solving Skills in Advanced Algebra. *JPAIR Multidisciplinary Research*, *1*(17). https://doi.org/10.7719/jpair.v17i1.282.

Ölmez, İ. B., & Ölmez, S. B. (2019). Validation of The Math Anxiety Scale with The Rasch Measurement Model. *Mathematics Education Research Journal*, *31*(1), 89–106. https://doi.org/10.1007/s13394-018-0244-8.

Pangma, R., Tayraukham, S., & Nuangchale, P. (2009). Causal Factors Influencing Adversity Quotient of Twelfth Grade and Third-Year Vocational Students. *Journal of Social Sciences*, *5*(4), 466–470. https://doi.org/10.3844/jssp.2009.466.470.

Paul, R., & Elder, L. (2019). *The Miniature Guide to Critical Thinking Concepts & Tools*. Rowman & Littlefield.

Phoolka, S., & Kaur, N. (2012). Adversity Quotient: A New Paradigm to Explore. *International Journal of Contemporary Business Studies*, *3*(4), 227-44.

Purwasih, R. (2020). Kemampuan Berpikir Kreatif Matematis Siswa SMP dalam Menyelesaikan Soal Pemecahan Masalah Ditinjau Dari Adversity Quotient Tipe Climber. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *8*(2), 323–332. https://doi.org/https://doi.org/10.24127/ajpm.v8i2.2118.

Puspitasari, I. W., Fauzan, G. A., & Bernard, M. (2016). Software Geogebra Untuk Meningkatkan Kemampuan Berpikir Logis Matematik Siswa SMP. *Journal On Education*, *01*(04), 679–687.

Rahayu, N., & Alyani, F. (2020). Kemampuan Berpikir Kritis Matematis ditinjau dari Adversity Quotient. *Prima: Jurnal Pendidikan Matematika*, *4*(2), 121. https://doi.org/10.31000/prima.v4i2.2668.

Rohaeti, E. E., & Bernard, M. (2018). the Students' Mathematical Understanding Ability Through Scientific-Assisted Approach of Geogebra Software. *Infinity Journal*, *7*(2), 165. https://doi.org/10.22460/infinity.v7i2.p165-172.

Sawilowsky, S. S. (2009). Very large and huge effect sizes. *Journal of Modern Applied Statistical Methods*, *8*(2), 597–599. https://doi.org/10.22237/jmasm/1257035100.

Soheila, B., & Rosemaliza, K. (2018). The Intention to Use GeoGebra in the Teaching of Mathematics among Malaysian Teachers. *Malaysian Online Journal of Educational Technology*, *6*(1), 109–115.

Stoltz, P. G. (2000). *Adversity Quotoient, Mengubah Hambatan Menjadi Peluang* (T. Hermaya (ed.); I). PT Gramedia Widiasarana Indonesia.

Sumintono, B., & Widhiarso, W. (2014). *Aplikasi Model Rasch untuk Penelitian Ilmu-Ilmu Sosial (Edisi Revisi)*. Trim Komunikata Publishing House.

Supandi, M., & Senam, S. (2020). Development of Science Learning Media-Based Local Wisdom Batui to Improve Critical Thinking Ability. *Jurnal Pendidikan Dan Pengajaran*, *52*(3), 163–171. https://doi.org/10.23887/jpp.v52i3.18149.

Suryaningrum, C. W., Purwanto, Subanji, Susanto, H., Ningtyas, Y. D. W. K., & Irfan, M. (2020). Semiotic Reasoning Emerges in Constructing Properties of a Recyangle : A Study of Adversity Quotient. *Journal on Mathematics Education*, *11*(1), 95–110. https://doi.org/http://doi.org/10.22342/jme.11.1.9766.95-110.

Syafitri, Q., Mujib, M., Netriwati, N., Anwar, C., & Wawan, W. (2018). The Mathematics Learning Media Uses Geogebra on the Basic Material of Linear Equations. *Al-Jabar : Jurnal Pendidikan Matematika*, *9*(1), 9. https://doi.org/10.24042/ajpm.v9i1.2160.

Wahyuni, M. (2020). *Statistik Deskriptif Untuk Penelitian Olah Data Manual dan SPSS 25*. CV. Bintang Surya Madani.

Wechsler, S. M., Saiz, C., Rivas, S. F., Vendramini, C. M. M., Almeida, L. S., Mundim, M. C., & Franco, A. (2018). Creative and Critical Thinking: Independent or Overlapping

Components? *Thinking Skills and Creativity*, *27*(November 2017), 114–122. https://doi.org/10.1016/j.tsc.2017.12.003.

Wulandari, I. P. (2020). Critical Thinking Ability in Terms of Adversity Quotient on DAPIC Problem Solving Learning. *UJMER: Unnes Journal of Msthematics Education Research*, *9*(1), 52–59.

Yanti, A. P., Koestoro, B., & Sutiarso, S. (2018). The Students' Creative Thinking Process Based On Wallas Theory In Solving Mathematical Problems Viewed From Adversity Quotient/Type Climbers. *Al-Jabar : Jurnal Pendidikan Matematika*, *9*(1), 51. https://doi.org/10.24042/ajpm.v9i1.2331.

Yurniwati, & Soleh, D. A. (2020). The effectiveness of computer-based problem solving to improve higher order thinking skills on prospective teachers. *International Journal of Instruction*, *13*(2), 393–406. https://doi.org/10.29333/iji.2020.13227a.