



## **THE MATHEMATICAL ARGUMENTATION ABILITY AND ADVERSITY QUOTIENT (AQ) OF PRE-SERVICE MATHEMATICS TEACHER**

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### **Abstract**

The Mathematical argumentation has been studied before, but no research has a focus on mathematical argumentation and adversity quotient of the pre-service mathematics teacher. This study is experimental research that aims to know and examine in depth about the influence of AQ of pre-service mathematics teacher toward the achievement of mathematical argument ability. The population of this study is the pre-service mathematics teacher in Cimahi City, West Java, Indonesia; while the sample is 60 pre-service mathematics teachers selected purposively. The instruments of this study are tests and non-tests. They are based on the assessment of good characteristics towards students' mathematical argumentation abilities, while the non-test instrument is based on the assessment of good characteristics towards AQ. The results of this research show that: (1) AQ gives positive influence to the development of mathematical argumentation ability of pre-service mathematics teacher with the influence of 60.2%, while the rest of it (39.8%) is influenced by other factors outside AQ; (2) The ability of mathematical argumentation of pre-service mathematics teacher is more developed on AQ of Climber type; (3) Students with the Quitter AQ type still tend to have less ability of mathematical argumentation.

**Keywords:** Adversity Quotient, Mathematical Argumentation

### **Abstrak**

Argumentasi matematis telah diteliti sebelumnya, namun belum ada penelitian yang memiliki fokus terkait argumentasi matematis dan adversity quotient mahasiswa calon guru matematika. Penelitian ini merupakan penelitian eksperimen yang bertujuan untuk mengetahui dan menelaah secara mendalam tentang pengaruh AQ mahasiswa calon guru matematika terhadap pencapaian kemampuan argumentasi matematis. Populasi dalam penelitian ini adalah mahasiswa calon guru matematika yang berada di Kota Cimahi, Jawa Barat, Indonesia. Sedangkan sampelnya sebanyak 60 orang mahasiswa calon guru yang dipilih secara purposif. Instrumen dalam penelitian ini menggunakan tes dan non tes. Instrumen tes tersebut didasarkan pada penilaian karakteristik yang baik terhadap kemampuan argumentasi matematis mahasiswa. Sedangkan instrumen non tes didasarkan pada penilaian karakteristik yang baik terhadap AQ. Hasil penelitian menunjukkan bahwa (1) Adversity Quotient (AQ) memberikan pengaruh yang positif terhadap pengembangan kemampuan argumentasi matematis mahasiswa calon guru, dengan besarnya pengaruh tersebut sebesar 60,2% sedangkan sisanya (39,8%) dipengaruhi oleh faktor lain di luar AQ; (2) Kemampuan argumentasi matematis mahasiswa calon guru lebih berkembang pada AQ tipe Climber; (3) Mahasiswa yang termasuk ke dalam AQ tipe Quitter masih cenderung kurang dalam kemampuan argumentasi matematis.

**Kata kunci:** Adversity Quotient, Argumentasi Matematis

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The ability of argument becomes important in teaching and learning process of mathematics. The Argument is a core of scientific thought (Cross, 2009). But in reality, there are still of pre-service mathematics teachers who have not done the argument process well. One of the factors causing students' less such ability is the lack of argumentation essence in maintaining their opinion logically. It is expected that they can do a rational process of building thinking in solving the problems being faced. Thus, a mathematical user can search for

forms, models, even tricks for in working on mathematics. It is due to the important role of mathematical argumentation becomes one of the goals in developing the appropriate capabilities in line with students' expertise (Inglis, Mejia-Ramos, & Simpson, 2007; Soekisno, 2015).

Arguments are closely related to the reasoning process. This is because the process of argumentation is a process undertaken by a person in analyzing information of reasoning process results about the problems and procedures to find a solution, and the results of the analysis will be communicated to others. Someone involved in argumentation aims to seek justification for his or her beliefs, attitudes, and values to influence others (Hershkowitz, Tabach, & Dreyfus, 2017; Hidayat, Wahyudin, & Prabawanto, 2018; Mercier & Sperber, 2011; Osborne, 2010).

An argument can be defined as a statement with justification. The argument is also the opinion of a conclusion supported by a reason. Soekisno (2015) explains that argument is a person's rationale for facing problems, issues, and arguing issues. The argument which is the solution to a problem consists of claims supported by various principles (guarantees), evidence and various objections (contra-arguments). The argument is seen as a product of reasoning process. In this way, it can be argued that the argument is derived from a process of reasoning (Dawson & Venville, 2008; Mercier & Sperber, 2011; Soekisno, 2015).

In achieving mathematical results, someone needs to use, in addition to cognitive abilities, affective aspects. One of the affective aspects a person has is Adversity Quotient (AQ). AQ can align someone's attitudes and behavior in solving problems of mathematics. AQ is a person's ability to deal with the difficulties he or she is experiencing. The fact that there are current students who easily give up in doing mathematical problems is due to difficulties in the process of solving the problems they are facing (Hidayat, 2017; Hidayat et al., 2018; MZ, Risnawati, Kurniati, & Prahmana, 2017; Parvathy & Praseeda, 2014; Yanti & Syazali, 2016).

There are 3 types of AQ, namely: Quitter (Low AQ), Camper (Medium AQ), and Climber (High AQ). A person with AQ Climber can more easily deal with the problems he or she is experiencing, but for individuals with AQ Quitter, he or she will have difficulty in dealing with solving problems (Hidayat, 2017; MZ et al., 2017; Parvathy & Praseeda, 2014; Phoolka & Kaur, 2012). One of the factors of students with AQ Quitter can occur because they are accustomed to learning with the completion algorithm that teachers teach through less innovative learning (Hendriana, Hidayat, & Ristiana, 2018; Hendriana, Rohaeti, & Hidayat, 2017; Panasuk & Lewis, 2012; Pangma, Tayraukham, & Nuangchalerm, 2009; Sundayana, Herman, Dahlan, & Prahmana, 2017). Thus, AQ is also considered a predictor of one's success in facing difficulties.

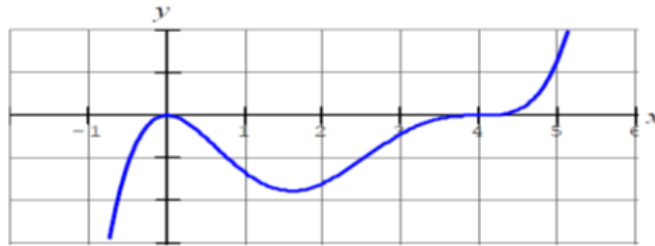
It is necessary to study in more depth about the relationship and influence of pre-service mathematics teacher AQ toward mathematical argumentation ability. Thus, the purpose of this study is to know and deeply analyze the influence of pre-service mathematics teacher AQ toward the ability of mathematical argumentation.

## **METHOD**

This study is experimental research that aims to know and examine in depth about the influence of AQ of pre-service mathematics teacher toward the achievement of mathematical argument ability. The population of this study is students of pre-service mathematics teacher in Cimahi City, West Java, Indonesia; while the

sample is 60 students of pre-service mathematics teachers selected purposively. The instruments of this study are tests and non-tests. They are based on the assessment of good characteristics towards students' mathematical argumentation abilities, while the non-test instrument is based on the assessment of good characteristics towards AQ. The data of the research results are processed and analyzed using the One-Way ANOVA statistical test. However, before it is conducted, the data normality test, linearity test and AQ regression test to mathematical argument ability are previously tested. As for examples, the test and non-test instruments are listed in the Figures 1 and 2 respectively.

Function graphic  $f(x)$  is given below:



- a) Suppose, the graphic displayed is the one from  $f(x)$ . Can the graphic be used for determining critical points, maximum & minimum local, maksimum & minimum absolute from  $f(x)$ ? Give the reasons.
- b) Suppose, the graphic displayed is the one from  $f'(x)$ , first derivative  $f$ . Can the graphic be used for determining critical points, maximum & minimum local, maksimum & minimum absolute from  $f(x)$ ? Give the reasons.
- c) Suppose, the graphic displayed is the one from  $f''(x)$ , second derivative  $f$ . Can the graphic be used for determining critical points, maximum & minimum local, maksimum & minimum absolute from  $f(x)$ ? Give the reasons.

Figure 1. Test instrument on students' mathematical argumentation ability

**ADVERSITY QUOTIENT SCALE**

The students' ability in controlling an event related to the difficulties they are facing in learning process can cause difficulties in the future.

No	Statements	Highly agreed	Aggred	Disagreed	Highly disagreed
1	I realize that not all mathematics items is as hard as I imagine				
2	The mathematics items make me challenge to finish them				
3	When receiving mathematics items, I feel not happy, my heart beats faster, I'm nervous				
4	Having mathematics assignment, I copy my friends' work				

Figure 2. Non-test instrument on students' adversity quotient

## RESULTS AND DISCUSSION

The results obtained that, it was found that the two variables namely AQ and students' mathematical argument ability have a normal distribution. Furthermore, the linearity test of students' mathematical argument ability on AQ with the test result is presented in Table 1.

Table 1. Test of linearity between AQ and mathematical argument ability

			Sum of Squares	df	Mean Square	F	Sig.
Mathematical Argumentation Ability* Adversity Quotient	Between Groups	(Combined)	163.305	20	8.165	5.167	0.000
		Linearity	135.375	1	135.375	85.668	0.000
		Deviation from Linearity	27.930	19	1.470	0.930	0.554
	Within Groups		61.629	39	1.580		
	Total		224.933	59			

Table 1 shows that Sig value obtained on "Deviation Form Linearity" is 0.554 which gives the conclusion that the AQ and students' mathematical argument ability have a linear relationship. The level of linearity between AQ and students' mathematical argument ability is strong (Sig = 0.000). Thus, it can be continued with regression test whose results are presented in Table 2 and Table 3.

Table 2: Regression test between AQ and mathematical argument ability

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	135.375	1	135.375	87.672	0.000 <sup>b</sup>
	Residual	89.558	58	1.544		
	Total	224.933	59			

a. Dependent Variable: Mathematical Argumentation Ability

b. Predictors: (Constant), Adversity Quotient Score

Table 2 shows it is apparent that, on the significance level of 5%, the Sig value of 0.000 resulted in that AQ had a significant influence on students' mathematical argument ability. Also, the level of the correlation coefficient is 0.776 with the coefficient of determination on AQ to students' mathematical argument ability is of 0.602. The result in that the level of influence of AQ to students' mathematical argument ability is equal to 60.2%, while other factors outside AQ influence the rest (39.8%).

Table 3: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.776 <sup>a</sup>	0.602	0.595	1.24262

a. Predictors: (Constant), Adversity Quotient Score

The result of the research indicates that there are influences of AQ towards the achievement of the students' mathematical argumentation ability. This is in line with the study of Leonard & Amanah (2014) who state that the mathematics learning achievement is affected by the AQ. Parvathy & Praseeda (2014) also holds that between the AQ and the process of the mathematical solving problem

of has a positive relationship. It is due It is due to the factor *reach* on one of AQ indicators was predicted to be a predictor in the process of solving the problem that someone did.

After knowing that AQ gives effect to the achievement of students' mathematical argumentation ability, then, the analysis of the results of their mathematical argumentation ability is also conducted based on the 3 AQ types, namely: Climber, Camper, and Quitter. As for the results of data processing by using the One-Way are presented in Table 4.

Table 4. One-Way ANOVA Test of AQ towards Mathematical Argumentation Ability

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	135.529	2	67.765	43.204	0.000
Within Groups	89.404	57	1.568		
Total	224.933	59			

Table 4 shows that it is apparent that there are significant differences between the achievement of mathematical argumentation by students with AQ Climber, Camper and Quitter (Sig. = 0.000). To figure out which type of AQ that is more influential towards mathematical argumentation ability, then, the post hoc test using Scheffe test is conducted and the results are presented in the following Table 5.

Table 5. Scheffe Test of Mathematical Argumentation Ability Based on AQ Types

AQ (I)	AQ (J)	I – J	Sig
Climber	Camper	1.06667	0.035
Climber	Quitter	3.89020	0.000
Camper	Quitter	2.82353	0.000

The Scheffe Test results, it is apparent that each type of AQ influences the achievement of mathematical argumentation ability, however, based on that data, it is apparent that the AQ which is more influential to the achievement of mathematical argumentation ability is Climber type. It is due the student with this type has more ability to solve problems being faced, and he or she still considers the steps in solving those problems. Also, the student with this AQ type can also be empowered to be a peer tutor for those with AQ Camper dan Quitter level (Hidayat, 2017; MZ et al., 2017). About the ability of mathematical argumentation possessed by the students with AQ types, it is now apparent that the students with AQ Climber type can solve the given problem based on the level of pre-existing understanding.

Figure 3 and Figure 4 shows that it appears that they already understand the minimum and maximum concepts of a curve. The answer is already in line with a good thinking process and contains data, claims, warrant, supporting arguments, and disclaimer. Also, it is apparent that the data, the supporting arguments and the guarantor mentioned above have supported many claims. The process of mathematical arguments done by the students is considered to be the level of good category (Beattie et al., 2006; Brown, Furtak, Timms, Nagashima, & Wilson, 2010; Cross, 2009; Dawson & Venville, 2008; Inglis et al., 2007; Soekisno, 2015).

a) Iya. Grafik tersebut dapat digunakan untuk menentukan titik kritis, maksimum dan minimum lokal, tetapi tidak dapat digunakan untuk mencari nilai maksimum dan minimum mutlak dari  $f(x)$  karena pada grafik tersebut memiliki batas-batas pada setiap intervalnya

Bukti :

o> Nilai maksimum adalah  $(-1,0)$ . karena pada titik tersebut grafik mencapai titik tertinggi sebelum akhirnya turun kembali.

o> Nilai minimum

o> Titik kritis adalah titik  $(a,b)$ . karena pada titik tersebut mempunyai nilai minimal lokal.

The graphic can be used for determining the critical point, maximum and minimum local, maximum & minimum absolute from  $f(x)$ , but can't be used to find the absolute maximum and minimum value of  $f(x)$  because the graph has limits on each interval.

Evidence :

1. The maximum value is  $(-1, 0)$ , because at that point the graph reaches its highest point before it finally descends again.
2. Minimum value.
3. The critical point is the point  $(a, b)$ , because at that point it has a local minimum value.

Figure 3. the Results of Students' work with AQ Climber

Data : *Graphic in items*

Claim : *Yes, that graphic can be used to determine critical points, maximum dan minimum.*

Disclaimer : *But it cannot be used to determine the maximum value and minimum absolute from  $f(x)$ .*

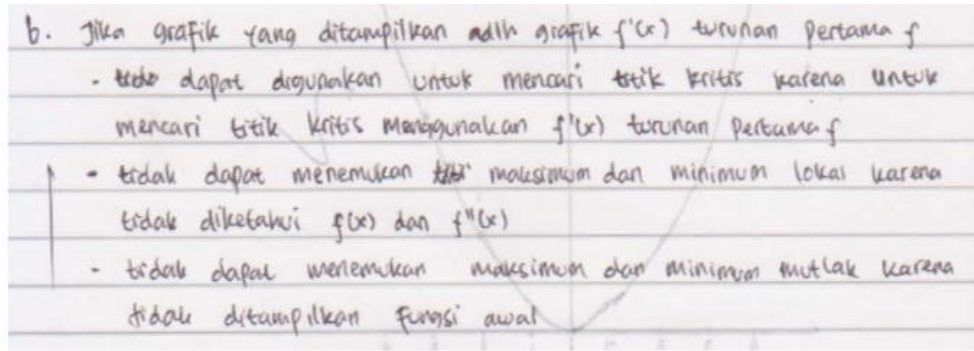
Guarantee : *On that graphic, there are limitations on each interval.*

Supporting arguments : *evidence: maximum value is  $(-1,0)$ , because on that points, the graphic reaches the maximum points before it finally goes down again. The critical points are points  $(a, b)$ , because on that points, there are local minimum values.*

Figure 4. The Process of Mathematical Argument of Students with AQ Climber

Different from the work and the process of mathematical argumentation done by students with the AQ Camper presented in Figure 5 and 6. They appear that the student already did the thinking process correctly, but the claim was still a problem. It is due to the answer and the process of mathematical argumentation done by him in giving the data and guarantee which are not directly related to supporting evidence in creating a claim. The student has actually understood the concept, but the process of completion done is still in the context of an imitative reasoning, which is the process of thinking that leads to the solution but based on learning by rote or the preceding algorithmic (Bergqvist & Lithner, 2012; Hershkowitz et al., 2017; Hidayat, 2017; Lithner, 2017).





If the graph shown is the graph of  $f'(x)$  being the first derivative of  $f$ , then:

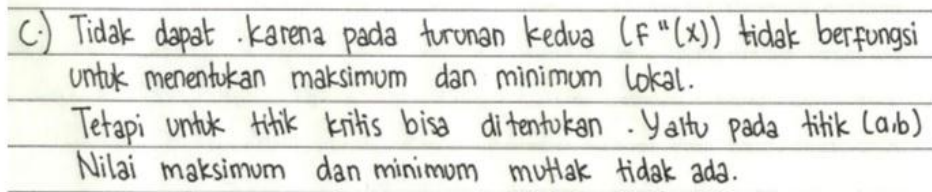
- Can not be used to find the critical point, because to find the critical point must be used  $f'(x)$  to be the first derivative of  $f$ .
- Can not find local maximum and minimum, because of unknown  $f(x)$  and  $f''(x)$ .
- Can not find the absolute maximum and minimum, because the initial function is not displayed.

Figure 5. The Results of Students with AQ Camper

Data : graphic in items  
 Claim : cannot be used to seek critical point.  
 Guarantee : to seek critical point using  $f'(x)$  first derivative  $f$ .

Figure 6. The Process of Mathematical Argument of Students with AQ Climber

In addition to students with Climber and Camper type, those with AQ Quitter appear to have difficulties in solving problems. It is due to the answers given by them which do not display a good argumentation process. The results of the work with the Quitter AQ are showing in Figure 7.



Can not. Because on the second derivative ( $f''(x)$ ) does not work to determine the local maximum and minimum. But for the critical point can be determined, that is at point (a, b). thus the maximum value and minimum absolute do not exist.

Figure 7. The Result of Student with AQ Quitter

Figure 7 shows the students' work with AQ Quitter still has difficulty in understanding the concept of the maximum, minimum by using the second derivative. The students provide an argument for answers containing data, claims, guarantees, and disclaimers. The claims and guarantees presented are false. Also, the disclaim is contradictory to the guarantee provided. Thus, individuals with AQ Quitter still fall into the low category of debating skills based on reasoning processes that have an impact on the ability to argue mathematically (Brown et al., 2010; Hidayat & Sariningsih, 2018;

Hidayat et al., 2018; Inglis et al., 2007; Johar & Yusniarti, 2018; Leonard & Amanah, 2014; Pangma et al., 2009; Saleh, Prahmana, & Isa, 2018).

## CONCLUSION

Adversity Quotient (AQ) gives a positive impact on the development of mathematical argumentation ability of pre-service mathematics teacher, with the effect of 60.2% while other factors outside AQ influence the rest (39.8%). Furthermore, the results of the study state also the ability of mathematical argumentation of pre-service mathematics teacher is more developed on AQ of Climber type. Finally, students with the Quitter AQ type still tend to have less ability of mathematical argumentation because their thinking pattern is still classified into imitative reasoning.

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