Jurnal Pendidikan Matematika
Volume 16, No. 2, May 2022, pp. 121-140
P-ISSN: 1978-0044, E-ISSN: 2549-1040, DOI: https://doi.org/10.22342/jpm.16.2.16633.121-140
Website: https://ejournal.unsri.ac.id/index.php/jpm
Accredited by SINTA 2: http://sinta2.ristekdikti.go.id/journals/detail?id=1811

Student Argumentation Structure in Solving Statistical Problems Based on Adversity Quotient

Iffanna Fitrotul Aaidati[1], Subanji[2], I Made Sulandra[3], Hendro Permadi[4]

[1]Mathematics Education Study Program, Faculty of Mathematics and Science, State University of Malang, Jl. Semarang No.5, Kota Malang, Indonesia
[2, 3, 4]Mathematics Assessment Study Program, Faculty of Mathematics and Science, State University of Malang, Jl. Semarang No.5, Kota Malang, Indonesia
Email: iffanna.fitrotul.2003118@students.um.ac.id

Abstract

Evaluation of the argumentation structure is needed to check the quality of student argumentation to produce appropriate problem-solving. Such evaluation can be carried out by identifying the constituent components of the argument. This study aims to describe the structure of student argumentation in solving statistical problems based on the Adversity Quotient (AQ). This qualitative descriptive type of research involved 52 students who were taking statistical methods courses. Participants were classified into three Categories of Adversity Quotient based on the results of the ARP (Adversity Response Profile) questionnaire. Data were obtained using statistical problem tests and interviews. The results showed that students with the AQ Climber category were able to meet all the constituent components of argumentation when solving statistical problems. AQ Camper-type students are only able to meet three components, namely claims, evidence, and reasoning. Meanwhile, students with the AQ Quitter type are only able to fulfill one component, namely claims. Based on the results of the study, the level of Adversity Quotient determines the quality of the student's argumentation structure when solving statistical problems.

Keywords: Argumentation, Statistics, Adversity Quotient

Abstrak

Evaluasi struktur argumentasi diperlukan untuk memeriksa kualitas argumentasi mahasiswa agar dapat menghasilkan penyelesaian masalah yang tepat. Evaluasi tersebut dapat dilakukan dengan mengidentifikasi komponen penyusun argumen. Penelitian ini bertujuan untuk mendeskripsikan struktur argumentasi mahasiswa dalam menyelesaikan masalah statistik berdasarkan *Adversity Quotient* (AQ). Penelitian berjenis deskriptif kualitatif ini melibatkan mahasiswa berjumlah 52 orang yang sedang mengambil mata kuliah metode statistik. Partisipan digolongkan ke dalam tiga kategori *Adversity Quotient* berdasarkan hasil angket ARP (*Adversity Response Profile*). Data diperoleh menggunakan tes masalah statistik dan wawancara. Hasil penelitian menunjukkan bahwa mahasiswa dengan kategori AQ *Climber* ketika menyelesaikan masalah statistik mampu memenuhi seluruh komponen penyusun argumentasi. Mahasiswa tipe AQ *Camper* hanya mampu memenuhi tiga komponen, yaitu klaim, bukti, dan penalaran. Sedangkan mahasiswa dengan tipe AQ *Quitter* hanya mampu memenuhi satu komponen, yaitu klaim. Berdasarkan hasil penelitian, dapat diketahui bahwa tingkatan *Adversity Quotient* menentukan kualitas struktur argumentasi mahasiswa ketika menyelesaikan masalah statistik.

Kata Kunci: Argumentasi, Statistik, *Adversity Quotient*

How to Cite: Aaidati, I. F., Subanji, Sulandra, I. M., Permadi, H. (2022). Student argumentation structure in solving statistical problems based on adversity quotient. *Jurnal Pendidikan Matematika, 16*(2), 121-140.

INTRODUCTION

Arguments are reasons that can be used to strengthen or reject ideas, opinions, or ideas. Arguments are also expressed as the output of the inference mechanism, which is part of the reasoning process (Mercier & Sperber, 2013). Argumentation is defined by (Hidayat et al., 2018) as a procedure to find a solution. Argumentation can also be expressed as a process of concluding to solve problems

Received January 8, 2022; Revised April 4, 2022; Accepted May 20, 2022

(Mueller et al., 2012). In line with that, (Cross et al., 2008) also states that argumentation is the core of a scientific thought that requires data or facts and a reasoning process to process data into a claim. Thus, argumentation can be expressed as a form of thinking to solve problems resulting from the reasoning process.

As part of the reasoning process, argumentation produces output in the form of conclusions. Conclusions in the argumentation process are based on logical data and facts. The data or facts used can be in the form of values or results obtained from measurement or observation activities (Bluman, 2009). Data from measurements or observations presented in the form of numbers is called quantitative data (Herhyanto, 2016). Quantitative data were processed and analyzed using statistical methods.

Statistical methods are methods used to collect, present, process, and conclude data (Herhyanto, 2016). The process of concluding data in statistical methods is part of inferential statistics. Inferential statistics are used to determine estimates and draw general conclusions through data samples (Hadi et al., 2018). Inferential statistics is important knowledge that must be possessed by a student in the process of interpreting the meaning of the symbols in data (Chasanah et al., 2020). Thus, inferential statistics is an important part of research activities that require drawing conclusions and interpreting data.

Inferential statistics are an important part of making research conclusions, requiring students to understand statistical problem solving well. Therefore, the focus of the problem in this study uses inferential statistics material. The selection of inferential statistics problems was based on the results of research (Rohana & Yunika, 2020), which found that students had difficulties when carrying out the reasoning process on inferential statistics. These difficulties include students struggling to determine the right way to solve statistical problems, as well as having difficulty understanding the basics of statistical problems, so they cannot conclude correctly (Haerudin & Nur, 2020).

Students' difficulties in the reasoning process can affect the resultant conclusions. A faulty reasoning process will result in poor decisions and/or arguments. According to (Mercier & Sperber, 2013), reasoning leads to knowledge deviation, resulting in bad decisions; therefore, reasoning must be argumentative so that the results can be justified. Therefore, it is necessary to evaluate the arguments to examine the argumentation scheme formed by students when reasoning about statistical problems so that students can make decisions correctly.

Argument evaluation can be done by using an argumentation scheme. Several studies have used Toulmin's argumentation scheme to evaluate, identify, and highlight the importance of reducing uncertainty in mathematical proofs (Cross et al., 2008; Inglis et al., 2007; Nordin & Björklund, 2018; Santoso et al., 2019; Umah et al., 2016). However, in this study, the argumentation scheme used is McNeill and Krajcik's argumentation scheme. This is based on the finding (Umah et al., 2016) that the argument structure in Toulmin's argumentation scheme is quite difficult to find complete in the arguments of students who are not experts in mathematics. McNeill and Krajcik's argumentation scheme has been used several times to evaluate students' mathematical arguments (Mcneill & Martin, 2011; Sadieda, 2019; Sutini et al., 2020).

McNeill and Krajcik's argumentation scheme is a development of Toulmin's argumentation scheme with a simplified structure. The structure consists of four components, namely claims, evidence, reasoning, and rebuttal (McNeill & Krajcik, 2011). A claim is a statement, conjecture, or answer to a particular question or phenomenon (Berland & McNeill, 2010; K. McNeill & Krajcik, 2008). Evidence is information, data, or documentation that supports claims, conclusions, or judgments (McNeill & Krajcik, 2011). The reasoning is an explanation that can be used to support evidence against claims (Sadieda, 2019). Meanwhile, the rebuttal is an alternative statement that contradicts the claim and is supported by evidence (McNeill & Krajcik, 2011). The schematic framework of McNeill and Krajcik's argumentation is presented in Figure 1 (Berland & McNeill, 2010).

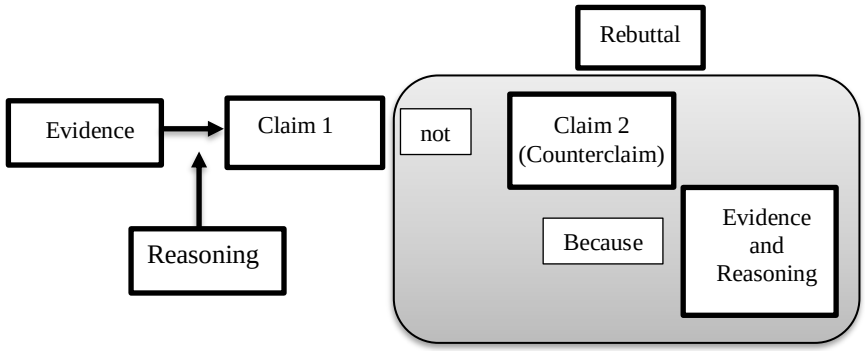


Figure 1. McNeill and Krajcik's argumentation framework

The scientific argumentation process requires hypotheses (claims), evidence construction, evidence evaluation, and drawing conclusions influenced by cognitive and non-cognitive abilities (Fischer et al., 2014). Arguments as part of reasoning can be used to develop higher-order thinking processes (Heng et al., 2014). A thought process is a form of mental activity that occurs in a person's mind (Yani et al., 2016), so non-cognitive abilities, such as how to overcome any difficulties in the problem-solving process, can be considered as a review. These considerations are based on the opinion (Hidayat et al., 2018) and (Hakim & Murtafiah, 2020) that one of the non-cognitive internal factors that influence student success is the ability to overcome difficulties in solving problems.

The ability to overcome difficulties is one of the factors that influence a person's way of reasoning when solving problems. This statement is based on the results of research conducted by (Khumairoh et al., 2020; Sanit & Sulandra, 2019), which found that the ability to overcome difficulties can affect a person's reasoning process. As shown in the previous paragraph, solving inferential statistics problems requires the ability to reason to produce correct conclusions, while the process of drawing correct conclusions requires argumentative reasoning. Thus, the ability to overcome difficulties is used as a review to analyze the argument structure in student arguments when solving statistical problems.

A person's ability to face difficulties when solving problems is called the Adversity Quotient (AQ). Adversity Quotient (AQ) was first expressed by (Stoltz, 1997) as an individual's resilience in dealing with problems. Over time, (Hidayat & Sariningsih, 2018) define the Adversity Quotient (AQ) as the intelligence of everyone to overcome every difficulty (Stoltz, 1997) divides Adversity Quotient

(AQ) into three types, namely Climber (high AQ), Camper (medium AQ), and Quitter (low AQ).

Adversity Quotient (AQ) has been used as a review or as a factor that affects various abilities of students and students in many studies, including (Hidayat et al., 2018; Hidayat, 2017; Lusiana et al., 2021; Sanit et al., 2019; Septiana, 2019; Supardi U.S., 2015). Based on the results of previous studies, this study uses the Adversity Quotient (AQ) as a review.

Meanwhile, in recent years, quite a few mathematics education researchers have tried to analyze students' arguments in solving various mathematical problems, including (Cross et al., 2008; Inglis et al., 2007; Nordin & Björklund, 2018; Sadieda, 2019; Santoso et al., 2019; Sutini et al., 2020; Umah et al., 2016). However, none of these studies have highlighted student arguments in solving statistical problems based on the Adversity Quotient (AQ). Therefore, this study seeks to make a theoretical contribution to improving students' argumentation skills, especially in solving statistical problems. This study aims to analyze the structure of students' argumentation in solving statistical problems based on their ability to deal with problems.

METHODS

This research is a descriptive study with a qualitative approach that was carried out at the State University of Malang. The research was conducted in the Odd Semester 2021/2022 in October 2021. The research subjects were 52 Semester 1 undergraduate student who were taking Statistical Methods lectures. Subjects were mapped into three types of Adversity Quotient (AQ) using the ARP (Adversity Response Profile).

The instruments used in this study were the ARP (Adversity Quotient Profile) questionnaire, which was adapted from (Putri, 2017) and (Septiana, 2019), statistical problem test sheets, and interview guide sheets. Data were collected using test and interview-based methods. The task is to analyze the structure of the argumentation and questionnaire to determine the type of student AQ. The determination of the category of student AQ is based on the scores obtained through filling out the ARP questionnaire. The score is taken from the negative conditions in each of the core dimensions of the responses in AQ. This dimension is termed CO2RE (Control Origin and Ownership Reach Endurance) AQ categories based on scores are presented in Table 1.

Table 1. Categories of adversity quotient

No.	Score	Category
1.	$147 \leq x \leq 200$	Climber
2.	$93 \leq x < 147$	Camper
3.	$x < 93$	Quitter

Data analysis techniques consist of an analysis of questionnaire results, analysis of test results, and analysis of interview results. The results of the statistical problem-solving test for each subject were analyzed for their argument structure based on the indicators of each component of McNeill and

Krajcik's arguments. The indicators for each argumentation component can be seen in Table 2.

Table 2. Argumentation component indicators in statistical problem solving

No.	Components	Indicators
1.	Claim	Able to provide initial answers/statements in accordance with the questions asked
2.	Evidence	Able to provide precise and sufficient data to confirm the correctness of the claim
3.	Reasoning	Able to properly explain the relationship between data and claim and show the reasons why the data can support/refute claims
4.	Rebuttal	Able to provide alternative statements that are contrary to claim, able to determine data supporting/disputing alternative statements, and able to explain the reasons for the data to support/refute alternative statements

Data from interviews were analyzed using a data reduction process, data presentation, and conclusion (Sugiyono, 2013). The findings from the results and discussion are summarized in Table 10, and conclusions are drawn.

RESULTS AND DISCUSSION

Based on the results of the ARP questionnaire and the AQ category in Table 1, three AQ Climber type subjects were obtained, four AQ Quitter type subjects and the remaining 45 subjects were the AQ Camper type. The test results of each subject for each type of AQ were analyzed for their argument structure based on the indicators in Table 2. Subjects were coded S_A for the AQ Climber type, S_B for the AQ Camper type, and S_c for the AQ Quitter type.

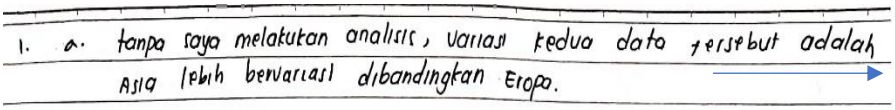
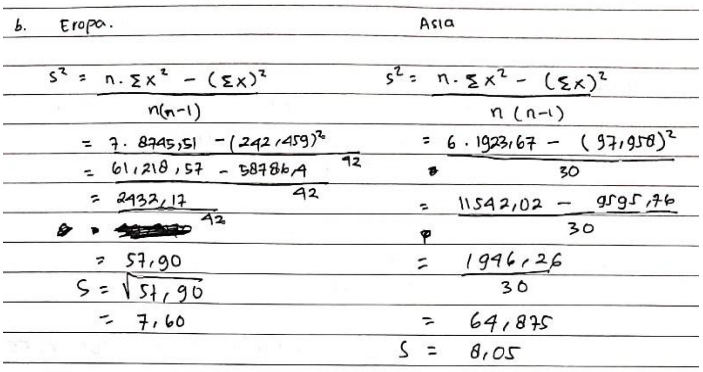
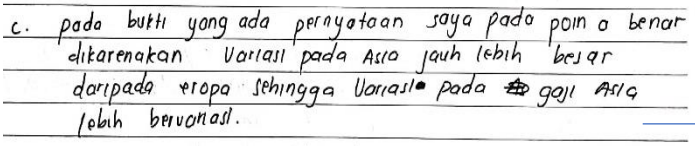
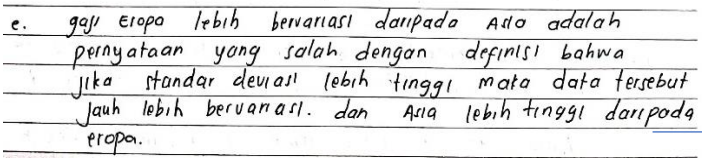
AQ Climber Subject Argument Structure (S_A)

Subjects with Climber type AQ can fulfill all the argumentation component indicators. However, there is one out of three subjects who deviate and cannot fulfill all the indicators of the argumentation component.

Subjects that Fulfill All Argument Component Indicators (S_{A1})

Subjects S_{A1} were able to fulfill all the argumentation component indicators when solving statistical problems. The results of the work and interview quote S_{A1} are presented in Table 3 and Table 4.

Table 3. Test Results and interviews for climber type subjects (subject coded S_{A1})

Written Answer Results	 1. a. tanpa saya melakukan analisis, variasi kedua data tersebut adalah Asia lebih bervariasi dibandingkan Eropa. → *claim* a. Asian data is more varied than in Europe  b. Eropa. / Asia $s^2 = \frac{n.\Sigma x^2 - (\Sigma x)^2}{n(n-1)}$ $= \frac{7.8745,51 - (242,459)^2}{42}$ $= \frac{61.218,57 - 58786,4}{42}$ $= \frac{2432,17}{42}$ $= 57,90$ $S = \sqrt{57,90}$ $= 7,60$ $s^2 = \frac{n.\Sigma x^2 - (\Sigma x)^2}{n(n-1)}$ $= \frac{6.1923,67 - (97,958)^2}{30}$ $= \frac{11542,02 - 9595,76}{30}$ $= \frac{1946,26}{30}$ $= 64,875$ $S = 8,05$ → *evidence*  c. pada bukti yang ada pernyataan saya pada poin a benar dikarenakan variasi pada Asia jauh lebih besar daripada Eropa sehingga variasi pada gaji Asia lebih bervariasi. → *reasoning* c. My statement is correct because the value of Asian variance is much greater than in Europe, so salary variations in Asia are more varied.  e. gaji Eropa lebih bervariasi daripada Asia adalah pernyataan yang salah dengan definisi bahwa jika standar deviasi lebih tinggi maka data tersebut jauh lebih bervariasi. dan Asia lebih tinggi daripada Eropa. → *rebuttal* e. European salaries are more varied than Asian ones. The statement is incorrect based on the definition that if the standard deviation is higher, then the data is more varied. The value of Asian data variance is higher than that of Europe.
Interview Result	P_1 : *Why did you decide to make such an assumption/statement?* $S_{A_{1,1}}$: *Because judging from his salary, the salary in Asia is more random. While the salary difference in Europe is not too far from each other.* P_2 : *Why did you decide to show this evidence?* $S_{A_{1,2}}$: *Because that way, the fact that Asian data is more varied can be known, and this way is very efficient and easy.* P_3 : *Why can the reasons you give justify your statement?* $S_{A_{1,3}}$: *In accordance with the evidence that has been calculated, Asia is more varied than Europe.* P_4 : *Why does this statement contradict your original statement?* $S_{A_{1,4}}$: *Because based on the calculated value of variance, Europe is much more varied than Asia is wrong.* P_5 : *Why do you think the evidence you provide supports false statements?* $S_{A_{1,5}}$: *Because the evidence I provide is according to the definition and results of the count*

Based on Table 3, the subject gives an exact claim in the form of assumptions that show variations in the data considering the data values listed in the question table. The assumption is stated in writing in the answer sheet (claim-coded answer) and stated orally in the interview (coded quote $S_{A_{1,1}}$). Thus, the assumption of both subjects matches the definition of a claim, that is, a statement that answers questions based on data (Ho et al., 2019).

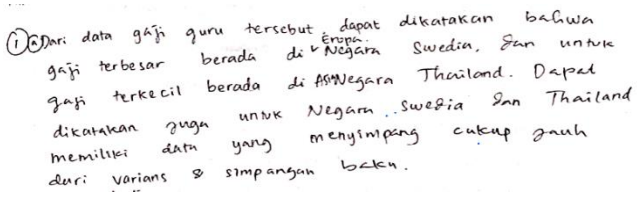
Subject S_{A_1} uses the formula of variance and standard deviation to confirm the correctness of the claim submitted (see the evidence-coded answer). The formula used and the result of the calculation indicate the exact result. This shows that there is a supporting evidence component of the claim that is data-appropriate and valid. These findings are in line with the statements of McNeill and Martin (2011) that evidence can be either observational data or reading sources.

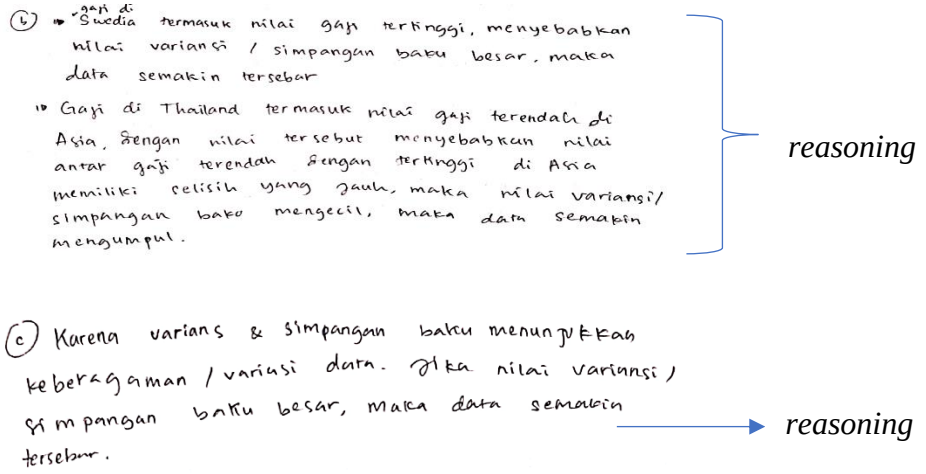
In Table 3, subject S_{A_1} writes down the reasons in writing (reasoning-coded answers) and orally (citations $S_{A_{1,2}}$) to explain why the subject provides supporting evidence for the claim using the variance formula. The subject also gives a proper explanation of the definition of the value of variance to justify the relationship between the claim and the evidence (citation $S_{A_{1,3}}$). Thus, the subject has carried out the right reasoning in his argumentation, thus generating the right decision. This is in accordance with the definition of reasoning that can be used to convince others through logical (Mercier & Sperber, 2011) arguments and is expressed based on information and knowledge obtained (Krawczyk, 2018) through classes of statistical methods. In the meantime, the component of the rebuttal delivered by the subject in writing can be well fulfilled (see rebuttal-coded answer). The subject gives a reason based on the definition of the variance value function in a data to explain why the alternative claim is false (citation $S_{A_{1,4}}$).

Deviant Subject (S_{A_2})

The subject of AQ *Climber* S_{A2} produces work that shows the incompleteness of the argumentation component, thus deviating from the other subject. The results of the work and interview of the subject are presented in Table 4.

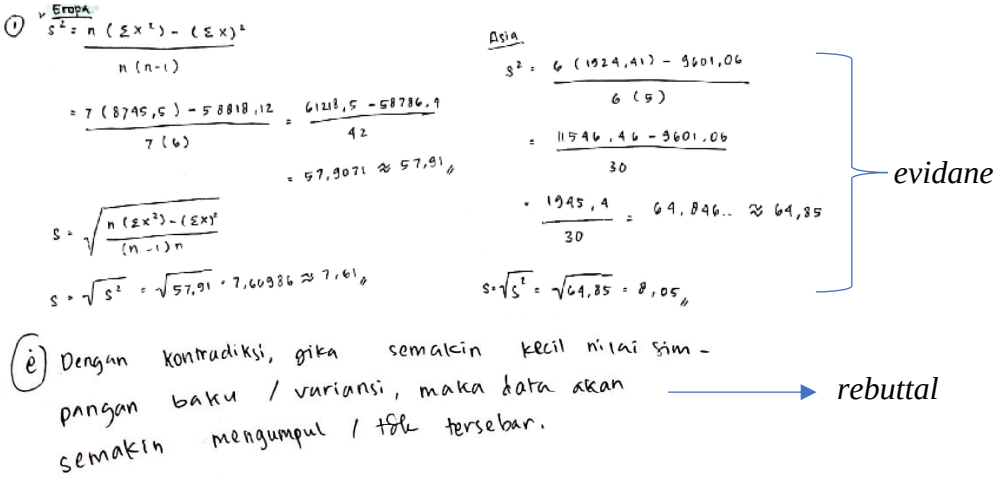
Table 4. Test Results and interviews for climber type subjects (deviant subject)

Written Answer Result	 *claim* a. Based on the teacher salary data on the table, the largest salary in Europe is Sweden, and the smallest salary in Thailand, so the Swedish and Thai state salaries are data that deviates far from the variance and deviation of standards.



b. Swedish state salary is the highest value, which causes the value of large variance and data to be spread more and more.
Thailand's state salary is among the lowest grades in Asia. The difference between the lowest salary and the highest in Asia is quite large, so the value of variance or standard deviation is getting smaller, and more and more data is collected.

c. Because variance and standard deviation indicate the diversity of data. If the variance value is large, then the data is increasingly scattered



e. The opposite statement is the smaller the variance value, the more collected/uncollected the data is collected/ not scattered.

Interviews Result	P_1 : *Why do you make such assumptions/statements?*	P_4 : *Why does this statement contradict your original statement?*
	$S_{A_{2,1}}$: *I looked at his payroll.*	$S_{A_{2,4}}$: *Because the statement is the opposite*
	P_2 : *Why did you show that evidence?*	P_5 : *Why don't you give evidence and written reasons to the statement of contradiction?*
	$S_{A_{2,2}}$: *Because usually so*	$S_{A_{2,5}}$: *(not answering)*
	P_3 : *Why can the reasons you give justify your statement?*	
	$S_{A_{2,3}}$: *Because there is such an explanation when in college*	

Based on Table 4, subject S_{A_2} gives a claim that does not correspond to the problem (see the result of the claim-coded answer). The question asked is the data that varies most based on the value of the data whereas the answers given by the subject only compare the variance between two data values,

not the value of the entire data, so the claims given do not correspond to the question. This contradicts the definition of a claim that is an answer to a question based on data or facts (Ho et al., 2019).

Subject S_{A_2} provides supporting evidence of the claim referring to the procedure for calculating the variance value and no miscalculation (see the results of the evidence-coded answer). Thus, subject can satisfy the evidence component with valid data. However, the subject cannot give a reason why he uses the procedure of calculating the variance value as supporting evidence of the claim (citation $S_{A_{2,,2}}$). He does not understand the concept of the usefulness of the value of the variance calculation to compare data (citations $S_{A_{2,3}}$). Thus, the components of reasoning are not well fulfilled in the argumentation of the subject S_{A_2}. The reasoning process carried out by the subject S_{A_2} is pseudo-reasoning that does not include actual reasoning, since the thought processes used are not logical and analytical (Subanji, 2011). Furthermore, the subject S_{A_2} gives a rebuttal in the arguments made but is unable to provide evidence of support as well as justification of the relationship between the evidence and the rebuttal both in writing and orally. Thus, the rebuttal given does not meet the definition of a rebuttal that requires data information as supporting evidence (Muratsu et al., 2015).

AQ Camper Subject Argumentation Structure (S_B)

Subjects with *Camper-type* AQ gave quite diverse responses in solving given statistical problems. Camper type AQ subject answer categories based on work results are presented in Table 5.

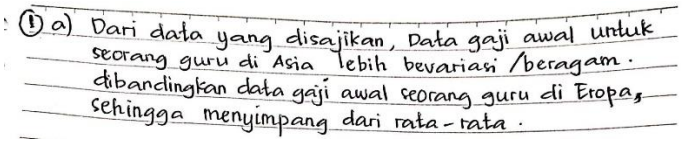
Table 5. Camper type subject answer categories

No	Answer Categories	Number of Subjects
1	Able to meet all indicators of argumentation components	2
2	Unable to meet component rebuttal indicators	28
3	Unable to meet component reasoning indicators	15

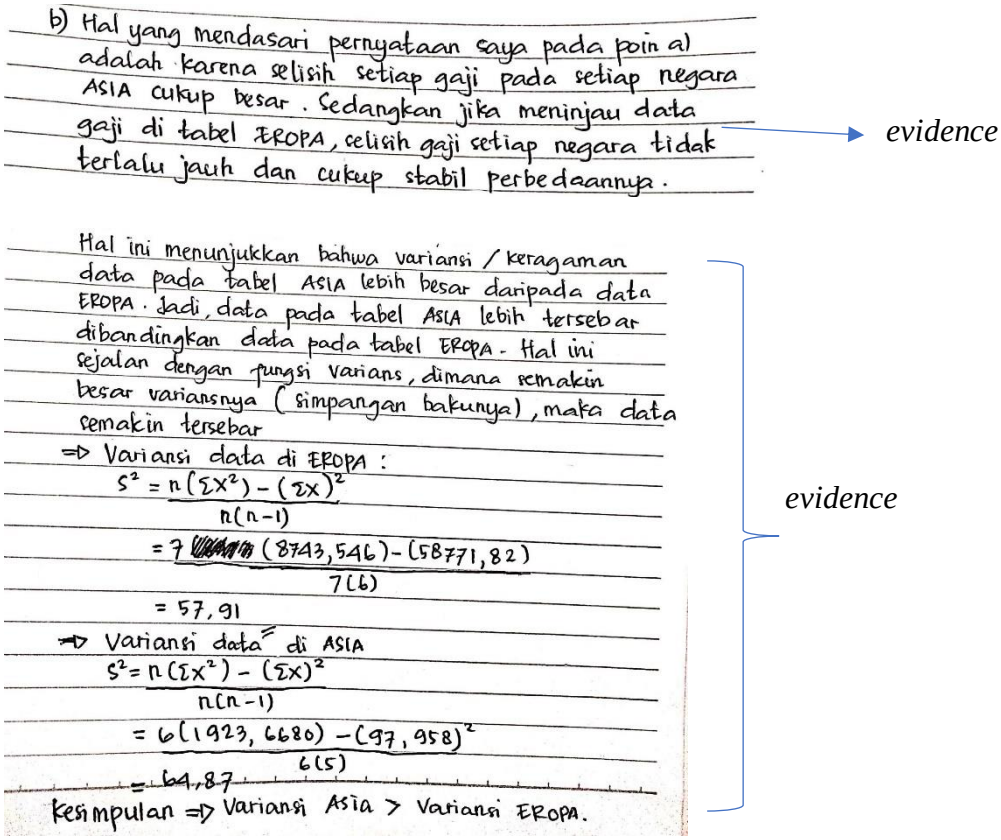
AQ Camper Category 1 Subject (S_{B_1})

Based on Table 5, 4% of the total Camper-type subjects can meet indicators of argumentation components. The results of the answers and excerpts of the subject's interview can be seen in Table 6.

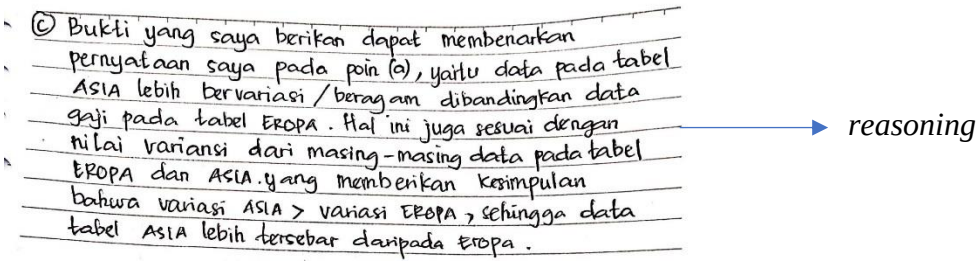
Table 6. Written test results and category 1 subject interviews (S_{B_1} subject coded)

Written Answers Result		*claim*

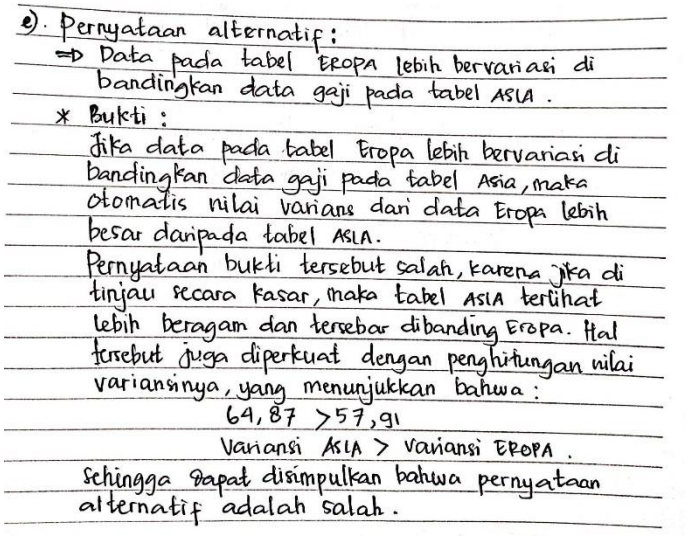
a. Based on the data presented, salary data in Asia is more varied than Europe, making it deviated than the average.



b. My previous statement was based on the difference in each Asian data, which was greater than the difference in data in Europe. The difference in data in Europe is not very significant. The reason is in line with the definition of the variance function; that is, the greater the variance or standard deviation, the more scattered the data.



c. The evidence I provide justifies my statement; that is, the data on the Asian table is more diverse than in Europe because the calculation value of Asian variance is greater than the calculated value of European variance.


e). Pernyataan alternatif :
⇒ Data pada tabel Eropa lebih bervariasi di bandingkan data gaji pada tabel Asia.
* Bukti :
Jika data pada tabel Eropa lebih bervariasi di bandingkan data gaji pada tabel Asia, maka otomatis nilai varians dari data Eropa lebih besar daripada tabel Asia.
Pernyataan bukti tersebut salah, karena jika di tinjau secara kasar, maka tabel Asia terlihat lebih beragam dan tersebar dibanding Eropa. Hal tersebut juga diperkuat dengan penghitungan nilai variansinya, yang menunjukkan bahwa :
64,87 > 57,91
Variansi Asia > variansi Eropa.
Sehingga dapat disimpulkan bahwa pernyataan alternatif adalah salah.

rebuttal

e. The data on the European table is more varied than the data on the Asian table.
Proof: if the data on the European table varies more than the data on the Asian table, then the European data variance value should be greater than that of Asia. The calculation value of variance obtained 64.87 > 57.91, Asian variance > European variance, so it can be concluded that the alternative statement is false and does not match the evidence of the calculation value of variance.

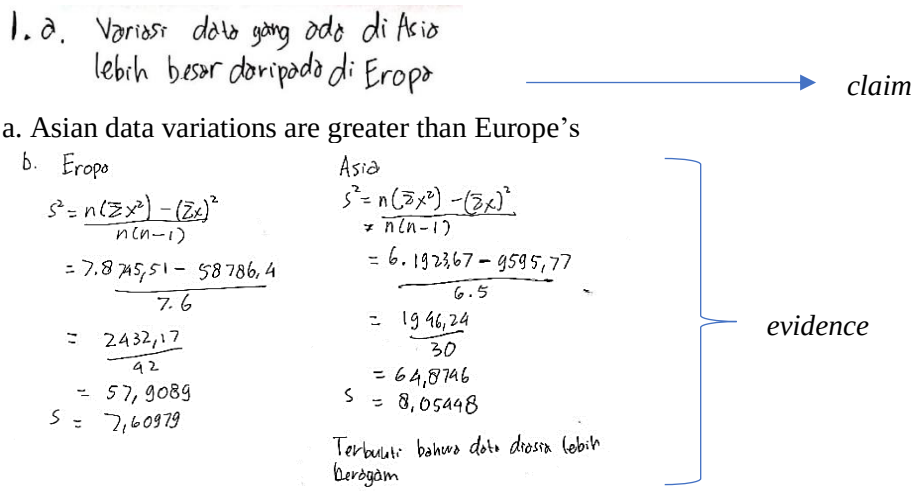
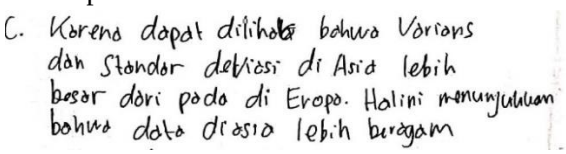
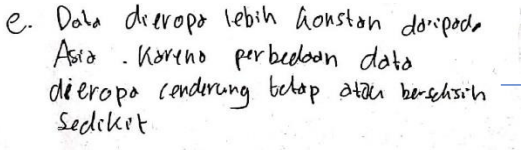
Interview Result	P_1 : *Why do you make such assumptions/statements?* $S_{B_{1,1}}$: *Because the difference in each teacher's salary in each country in Asia is quite large compared to salary data in Europe, I conclude so.* P_2 : *Why did you show that evidence?* $S_{B_{1,2}}$: *Because according to the function definition of variance, the more the data is scattered, the greater the variance, so, based on the calculation value of variance, my assumption is correct. So, this is evidence I need to support my statement.* P_3 : *Why does this statement contradict your original statement?* $S_{B_{1,3}}$: *Because the statement is false, it is contrary to the initial assumption.* P_4 : *Why do you give evidence and written reasons for the statement of contradiction?* $S_{B_{1,4}}$: *To show that the statement of contradiction is false.*	

Based on Table 6, subject S_{B_1} conveys assumptions about the comparison of variations of two data precisely based on the data provided. Such assumptions meet the definition of a claim that a claim is a statement on a question that corresponds to the data (McNeill & Martin, 2011). The subject justifies the claim using evidence based on data and the calculated value of variance with the right calculation so that the accuracy of the evidence supporting the claim can be ascertained, as expressed by (Muratsu et al., 2015). The subject is also able to clearly explain the relationship between the evidence and the claim and how the evidence can support the claim. The rebuttals presented by the subject are also supported using evidence that corresponds to the theory of variance, so the rebuttal given becomes a fairly strong argument (Muratsu et al., 2015).

AQ Camper Category 2 Subjects (S_{B_2})

Based on Table 5, as many as 62% of *Camper* AQ-type subjects cannot meet the rebuttal component indicator. The results of the work and quotations of the subject interview are presented in Table 7.

Table 7. Written test results and category 2 subject interviews (S_{B_2} subject coded)

Written Answer Result	 a. Asian data variations are greater than Europe's b. It is proven that Asian data is more diverse  c. Because Asia's variance and standard deviation are larger than that of Europe. This shows that Asian data is more diverse.  e. Data in Europe is more constant than Asia because the difference in data in Europe has a slight difference.
Interview Result	P_1 : *Why do you make such assumptions/statements?* $S_{B_{2,1}}$: *Because the difference in the largest and smallest values in Asia is greater than the difference in the largest and smallest values in Europe.* P_2 : *Why did you show that evidence?* $S_{B_{2,2}}$: *Because standard deviations and variants can show the diversity of a data* P_3 : *Why can the reasons you give justify your statement?* $S_{B_{2,3}}$: *Because the standard deviation value and large variance indicate that the data is increasingly diverse* P_4 : *Why does this statement contradict your original statement?* $S_{B_{2,4}}$: *I just flipped it over* P_5 : *Why don't you give evidence and written reasons for the statement of contradiction?* $S_{B_{2,5}}$: *Because the statement is worth the same as the initial statement that has been proven to be true.*

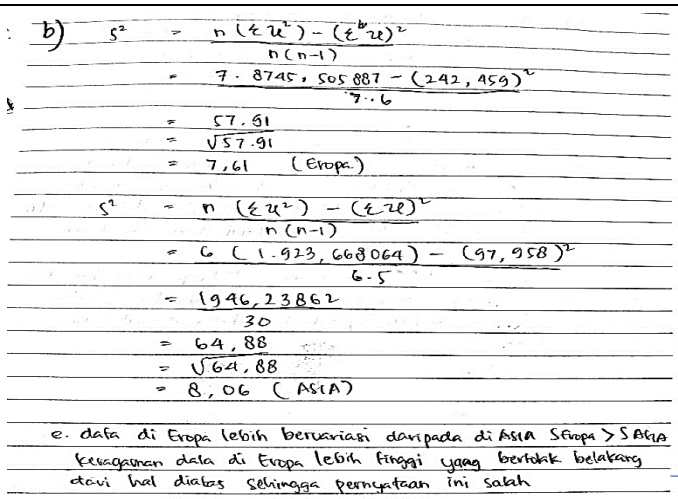
Based on Table 7, subject S_{B_2} presents a statement that is as true as the initial assumption (*see results of the rebuttal coded answer)*. The rebuttal is only an initial statement that is paraphrased and does not show any different meaning. In addition, the subject is also unable to provide evidence that can state that the rebuttal is false, as expressed in the quotation $S_{B_{2,5}}$. This does not fit the definition of a snatch, which is a reply that contradicts the claim and requires supporting evidence (Berland & McNeill, 2010). The error made by the subject indicates a lack of understanding of refutation in argumentation. (Muratsu et al., 2015).

AQ Camper Category 3 Subjects (S_{B_3})

In Table 5, as many as 33% of AQ *Camper* subjects cannot meet the reasoning component. The results of written answers and excerpts of the subject's interview are presented in Table 8.

Table 8. Written test results and category 3 subject interviews (S_{B_3} subject coded)

Written Answer Result	1. a. berdasarkan tabel variasi pada tabel ASIA bisa dikatakan lebih beragam dibanding yang di Eropa dikarenakan data di Eropa lebih mendekati data-data yang ada (selisih dari data-datanya tidak terlalu besar). Dan yang di ASIA selisih datanya bisa dianggap cukup besar Based on the data on the table, the variety of Asia is more diverse than in Europe, because Europeans have a difference that is not too large, while in Asia, the difference in data is quite large.	*claim*
	b. pada fungsi variansi dan simpangan baku berlaku jika semakin besar nilai variansi dan simpangan baku maka semakin beragam juga data yang diberikan dan pada data yang diberikan dapat diketahui bahwa selisih dari data-data Eropa dan data-data ASIA bisa didapat bahwa data di ASIA lebih bervariasi karena selisih-selisih datanya lebih besar c. Dikarenakan 2 data yang tersebar di Eropa yang bisa kita lihat selisihnya cukup besar yang membuat bingung dimana data variasi di ASIA apakah lebih besar dari data yang di Eropa Standard variance and deviation functions to show that the greater the value of variance and standard deviation, the more diverse the data. Meanwhile, the difference between Asian data is greater than Europe, so Asia is more varied.	*reasoning*



Since the two largest data in Europe is quite large difference, this confuses and doubts the assumption that Asian data is bigger than European data.

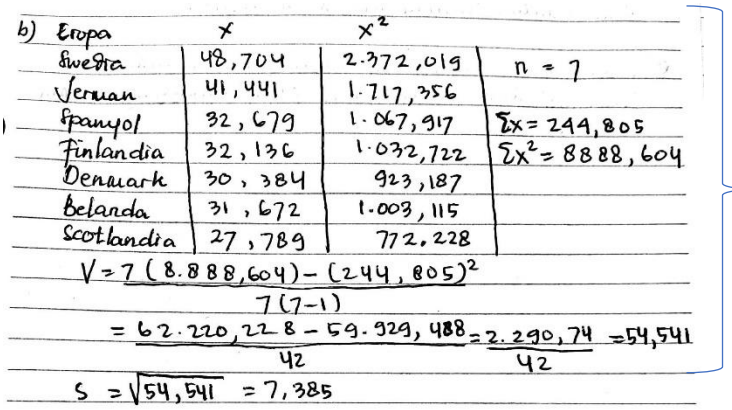
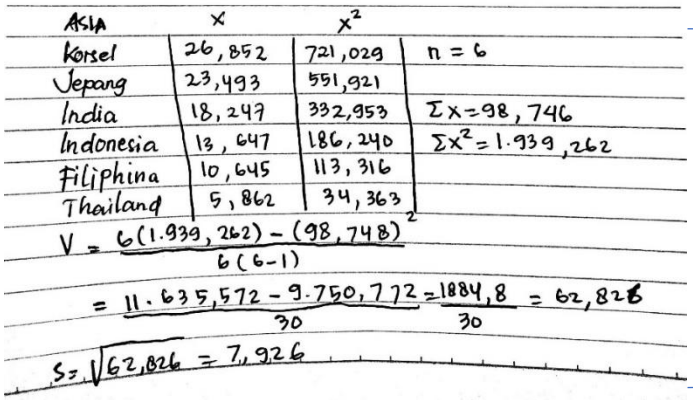
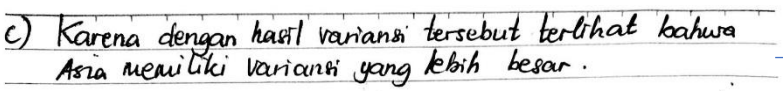
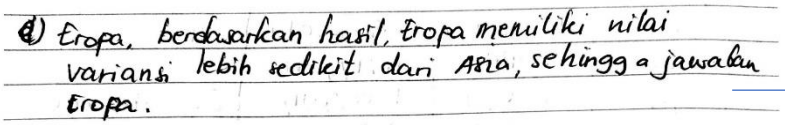
Interview Result	P_1 : *Why do you make such assumptions/statements?* $S_{B_{3,1}}$: *Because the difference from data in Asia is greater than the difference in data in Europe* P_2 : *Why did you show that evidence?* $S_{B_{3,2}}$: *For my initial statement to be tested and valid* P_3 : *Why can the reasons you give justify your statement?* $S_{B_{3,3}}$: *Because there are some data in Europe that is greater than data in Asia*	P_4 : *Why does this statement contradict your original statement?* $S_{B_{3,4}}$: *Because proving the initial statement can also be done by using the negation* P_5 : *Why do you give evidence and reason to the statement of contradiction?* $S_{B_{3,5}}$: *Because the evidence shows the negation of the initial statement is false, thus justifying the initial statement.*

Based on Table 8, when reasoning, the subject tends to focus on what he has believed, instead of looking at the data that has been provided as evidence. The subject has realized that the evidence in the form of a given variance calculation value can test the correctness of the claim. However, the subject repeats the claim as a justification for the relationship between the evidence and the claim (*see the results of the reasoning coded answer and the quote* $S_{B_{3.3}}$). Subjects tend to ignore theories that have been studied, even though the basis has already been disclosed when making evidence. According to (Lizotte et al., 2003), the reasoning component becomes one of the difficulties for students in conducting scientific arguments due to lack of understanding of the context of the problem.

AQ Quitter Subject Argumentation Structure (S_C)

Based on the results of the study, subjects with Quitter-type AQ could not meet more than one component of argumentation. The results of the answers and excerpts of the subject's interview are shown in Table 9.

Tabel 9. Camper type subject test and interview results

Written Answer Results	a) Asia lebih bervariasi dari Eropa. Asia is more varied than Europe → *claim*  b) Eropa: Swedia 48,704; 2.372,019 — Jerman 41,441; 1.717,356 — Spanyol 32,679; 1.067,917 — Finlandia 32,136; 1.032,722 — Denmark 30,384; 923,187 — Belanda 31,672; 1.003,115 — Scotlandia 27,789; 772.228. n = 7, $\Sigma x = 244,805$, $\Sigma x^2 = 8888,604$ $V = \frac{7(8.888,604) - (244,805)^2}{7(7-1)} = \frac{62.220,228 - 59.929,488}{42} = \frac{2.290,74}{42} = 54,541$ $S = \sqrt{54,541} = 7,385$ → *evidence*  Asia: Korsel 26,852; 721,029 — Jepang 23,493; 551,921 — India 18,247; 332,953 — Indonesia 13,647; 186,240 — Filiphina 10,645; 113,316 — Thailand 5,862; 34,363. n = 6, $\Sigma x = 98,746$, $\Sigma x^2 = 1.939,262$ $V = \frac{6(1.939,262) - (98,748)^2}{6(6-1)} = \frac{11.635,572 - 9.750,772}{30} = \frac{1884,8}{30} = 62,826$ $S = \sqrt{62,826} = 7,926$ → *evidence*  c) Karena dengan hasil variansi tersebut terlihat bahwa Asia memiliki variansi yang lebih besar. → *reasoning* Because with the results of this variance, Asia has a greater variance.  d) Eropa, berdasarkan hasil, Eropa memiliki nilai variansi lebih sedikit dari Asia, sehingga jawaban Eropa. → *rebuttal* Based on European results, Europe has less variance value than Asia, so the European's data are the answer
Interview Result	P_1 : *Why do you make such assumptions/statements?* S_{C_1} : *Because the Asian ones look varied in data* P_2 : *Why did you show that evidence?* S_{C_2} : *Because it's easy to do* P_3 : *Why can the reasons you give justify your statement?* S_{C_3} : *because it became clear with the evidence that I gave* P_4 : *Why does this statement contradict your original statement?* S_{C_4} : *Because it can be seen from the evidence I gave, then if the answer is like that it becomes wrong.* P_5 : *Why don't you give evidence and written reasons to the statement of contradiction?* S_{C_5} : *I think it's because it's wrong, so I don't have to provide the evidence*

Based on Table 9, subject S_C made an error in the calculation of the variance value (evidence-coded answer), so the data became invalid. Invalid data cannot be used as supporting evidence of the claim (Faizah et al., 2018). Subject S_C also incapable of properly explaining the relationship between the evidence and the claim (reasoning and citation-coded answers $S_{C_2}$and S_{C_3}). Thus, the reasoning component can also not be fulfilled by the subject S_C because it does not correspond to the definition of reasoning that requires precise information to generate appropriate explanations or thoughts (Krawczyk, 2018) .

Subject S_C expresses a rebuttal to the claims made, but the evidence shown by the subject as a supporter of the rebuttal is not true. This is due to an improper calculation process. In addition, through the excerpts of the interview, the subject does not feel the need to provide additional evidence to support the rebuttal statement because they think it must be false (citation S_{C_5}). This shows a weak quality of rebuttal due to false supporting evidence. According to (Muratsu et al., 2015), a rebuttal with weak qualities is a rebuttal that does not have adequate information to be able to convince others that the statement is true or false.

Based on the results of research and discussion, a summary of the structure of the subject's arguments can be obtained in solving statistical problems based on the type of Adversity Quotient. A summary of the research findings about student argumentation structure in solving statistical problems based on Adversity Quotient is presented in Table 10.

Table 10. Summary of research results of student argumentation structure in solving statistical problems based on adversity quotient

Adversity Quotient Type	Argumentation Component							
	Claim		Evidence		Reasoning		Rebuttal	
	F	NF	F	NF	F	NF	F	NF
Climber	2	1	2	1	2	1	2	1
Camper	45	-	45	-	30	15	17	28
Quitter	3	1	1	3	1	3	-	4

Information:

F : Fulfilled
NF : Not Fulfilling
The number in the column indicates the number of subjects

Based on Table 10, it was found that subjects with the Adversity Quotient of the Climber category could meet all the constituent components of the argument well according to the indicators. Subjects with Camper's category Adversity Quotient are only able to properly satisfy the components of claim, evidence, and reasoning, whereas the rebuttal is not satisfied due to errors in providing alternative claims and invalid supporting evidence. Meanwhile, subjects with the Adversity Quotient of the Quitter category are only able to meet the components of the claim well according to the indicators due to the subject's error in providing evidence, the process of erroneous reasoning due to non-factual reasons, and rebuttals that are not supported by evidence.

The results also showed that there were subjects with Climber-type Adversity Quotient who were unable to meet all the indicators of the argumentation component to the ethics of solving statistical problems. The subject makes a mistake in understanding how to compare the most diverse data, resulting in improper claims and data, the reasoning and refutations carried out are also not based on valid data. Meanwhile, it was also found that there were subjects with Camper-type Adversity Quotient who were able to meet all the indicators of the constituent components of the arguments properly and correctly. These findings require future re-research to be able to determine the causal factors for the existence of subjects who have a different argumentation structure than the majority in their group.

CONCLUSION

The structure of student argumentation with the Adversity Quotient of the Climber category when solving statistical problems meets all components of the argument well, namely claims, evidence, reasoning, and rebuttals. The structure of student argumentation with the Adversity Quotient of the Camper category when solving statistical problems only satisfies the components of argumentation of claims, evidence, and reasoning. Meanwhile, the structure of student argumentation with the Adversity Quotient of the Quitter category is only fulfilled by one component, namely claims. The findings show differences in the quality of student argumentation structures based on the level of Adversity Quotient when solving statistical problems. The difference in the quality of the argumentation can be caused by various factors and the discussion to improve the quality of student argumentation is a research discussion that can be used in the future.

ACKNOWLEDGMENTS

Thank you to the lecturers of teaching practice who have allowed me to do research in the taught classes. Thank you also to the two supervisors who helped the process of making this article so that it could be completed properly.

REFERENCES

Berland, L. K., & McNeill, K. L. (2010). A learning progression for scientific argumentation: Understanding student work and designing supportive instructional contexts. *Science Education*, *94*(5), 765–793. https://doi.org/10.1002/sce.20402

Bluman, G. A. (2009). *Elementary Statistics: a step by step approach 7th Edition.* New York: McGraw-Hill.

Chasanah, A. N., Wicaksono, A. B., Nurtsaniyah, S., & Utami, R. N. (2020). Analyze The Students's Mathematics Literacy Abilities in Inferenstial Statistics Subject Based on the Learning Styles.

Edumatica Jurnal Pendidikan Matematika, *10*(2). https://doi.org/https://doi.org/10.22437/edumatica.v10i2.10621

Cross, D., Taasoobshirazi, G., Hendricks, S., & Hickey, D. T. (2008). Argumentation: A strategy for improving achievement and revealing scientific identities. *International Journal of Science Education*, *30*(6), 837–861. https://doi.org/10.1080/09500690701411567

Faizah, L., Probosari, R. M., & Karyanto, P. (2018). Application of Problem Based Learning to Improve Oral Argumentation Skills of Class XI Students on Biological Learning. *Jurnal Biotek*, *6*(2). https://doi.org/https://doi.org/10.24252/jb.v6i2.6395

Fischer, F., Kollar, I., Ufer, S., Sodian, B., & Hussmann, H. (2014). Scientific Reasoning and Argumentation: Advancing an Interdiciplinary Research Agenda in Education. *Frontline Learning Research*, *5*, 28–45. https://doi.org/https://doi.org/10.14786/flr.v2i2.96

Hadi, S., Gunawan, I., & Dalle, J. (2018). *Statistical Inferential Theory and Its Application*.

Haerudin, H., & Nur, I. R. D. (2020). Analysis of Student Difficulties in Inferential Statistics Courses. *Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika, Dan Statistika*, *1*(3). https://doi.org/10.46306/lb.v1i3

Hakim, F., & Murtafiah, M. (2020). Adversity Quotient and Resilience in Mathematical Proof Problem-Solving Ability. *MaPan: Jurnal Matematika Dan Pembelajaran*, *8*(1), 87. https://doi.org/10.24252/mapan.2020v8n1a7

Heng, L. L., Surif, J., & Seng, C. H. (2014). Individual versus group argumentation: Student's performance in a Malaysian context. *International Education Studies*, *7*(7), 109–124. https://doi.org/10.5539/ies.v7n7p109

Herhyanto, N. (2016). *Education Statistics.* Tangerang Selatan: Universitas Terbuka.

Hidayat, W. (2017). Adversity Quotient and Mathematical Creative Reasoning of High School Students In Argument Driven Learning. *Kalamatika:Jurnal Pendidikan Matematika*, *2*(1), 15–28. https://doi.org/https://doi.org/10.22236/KALAMATIKA.vol2no1.2017pp15-28

Hidayat, W., & Sariningsih, R. (2018). Mathematical Problem-Solving Ability and Adversity Quotient of Junior High School Students Through Open Ended Learning. *JNPM (Jurnal Nasional Pendidikan Matematika)*, *2*(1), 109–118.

Hidayat, W., Wahyudin, & Prabawanto, S. (2018a). 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

Hidayat, W., Wahyudin, W., & Prabawanto, S. (2018b). Improving students' creative mathematical reasoning ability students through adversity quotient and argument driven inquiry learning. *Journal of Physics: Conference Series*, *948*(1). https://doi.org/10.1088/1742-6596/948/1/012005

Hidayat, Wahyu., Herdiman, Indri., Aripin, Usman., Yuliani, Anik., & Maya, R. (2018). Adversity Quotient (AQ) and Mathematical Creative Reasoning of Prospective Teacher Students. *Jurnal Elemen*, *4*(2), 230. https://doi.org/10.29408/jel.v4i2.701

Ho, H. Y., Chang, T. L., Lee, T. N., Chou, C. C., Hsiao, S. H., Chen, Y. H., & Lu, Y. L. (2019). Above- and below-average Students Think Differently: Their scientific argumentation patterns. *Thinking Skills and Creativity*. https://doi.org/10.1016/j.tsc.2019.100607

Inglis, M., Mejia-Ramos, J. P., & Simpson, A. (2007). Modelling mathematical argumentation: The importance of qualification. *Educational Studies in Mathematics*, *66*(1), 3–21. https://doi.org/10.1007/s10649-006-9059-8

Khumairoh, B., Amin, S. M., & Wijayanti, P. (2020). Proportional Reasoning of Middle School Students in Solving Mathematical Problems Viewed from Adversity Quotient. *PEDAGOGIA: Jurnal Pendidikan*, *9*(1). https://doi.org/10.21070/pedagogia.v%vi%i.259

Krawczyk, D. C. (2018). Introduction to Reasoning. In *Reasoning* (pp. 1–11). Elsevier. https://doi.org/10.1016/b978-0-12-809285-9.00001-6

Lizotte, D. J., Harris, C. J., Mcneill, K. L., Marx, R. W., & Krajcik, J. (2003). Usable Assessments Aligned with Curriculum Materials: Measuring Explanation as a Scientific Way of Knowing. In *Annual meeting of the American Educational Research Association*.

Lusiana, R., Suprapto, E., Sukristini, I., Studi, P., & Matematika, P. (2021). The Effectiveness of Problem Based Learning (PBL) on Mathematics Learning Achievement in terms of Student Adversit. *Edumatica Jurnal Pendidikan Matematika*, *11*(2). https://doi.org/https://doi.org/10.22437/edumatica.v11i02.7670

McNeill, K. L., & Krajcik, J. (2011). *Supporting grade 5-8 students in constructing explanation in science.* London, UK: Pearson.

Mcneill, B. K. L., & Martin, D. M. (2011). Demystifying data during a unit on simple machines. *National Research Council (NRC 1996)*.

McNeill, K., & Krajcik, J. (2008). Inquiry and scientific explanations: Helping students use evidence and reasoning. In *Science as Inquiry in The Secondary Setting*.

McNeill, K. L., & Krajcik, J. (2009). Synergy between teacher practices and curricular scaffolds to support students in using domain-specific and domain-general knowledge in writing arguments to explain phenomena. *Journal of the Learning Sciences*, *18*(3), 416–460. https://doi.org/10.1080/10508400903013488

McNeill, K. L., & Martin, D. M. (2011). Claims, Evidence, and Reasoning. *Science and Childern*. www.nsta.org/SC1104

Mercier, H., & Sperber, D. (2011). Why do humans' reason? Arguments for an argumentative theory. *Behavioral and Brain Sciences*, *34*(2), 57–74. https://doi.org/10.1017/S0140525X10000968ï

Mercier, H., & Sperber, D. (2013). Why do humans' reason? Arguments for an argumentative theory. *Behavioral and Brain Sciences, Cambridge University Press (CUP)*, *34*(2), 57–74. https://doi.org/10.1017/S0140525X10000968

Mueller, M., Yankelewitz, D., & Maher, C. (2012). A framework for analyzing the collaborative construction of arguments and its interplay with agency. *Educational Studies in Mathematics*, *80*(3), 369–387. https://doi.org/10.1007/s10649-011-9354-x

Muratsu, K., Inagaki, S., Yamaguchi, E., Yamamoto, T., Sakamoto, M., & Kamiyama, S. (2015). An Evaluation of Japanese Elementary Students' Understanding of the Criteria for Rebuttals in Argumentation. *Procedia - Social and Behavioral Sciences*, *167*, 91–95. https://doi.org/10.1016/j.sbspro.2014.12.648

Nordin, A. K., & Björklund, B. L. (2018). A framework for identifying mathematical arguments as supported claims created in day-to-day classroom interactions. *Journal of Mathematical Behavior*, *51*, 15–27. https://doi.org/10.1016/j.jmathb.2018.06.005

Putri, M. E. (2017). *Student Creative Thinking Process in Solving Open-Ended Problems Reviewed from Adversity Quotient (AQ) Students*. State University of Malang: Unpublished Thesis.

Rohana, R., & Yunika, L. N. (2020). Students' Statistical Reasoning in Statistics Method Course, Online Submission. *Jurnal Pendidikan Matematika*, *14*(1), 81–90. https://doi.org/https://doi.org/10.22342/jpm.14.1.6732.81-90

Sadieda, L. U. (2019). Ability to argue students through inductive thinking models with probing-prompting learning methods. *Pythagoras: Jurnal Pendidikan Matematika*, *14*(1), 23–32. https://doi.org/10.21831/pg.v14i1.24038

Sanit, I. N., & Sulandra, I. M. (2019). Student Algebraic Reasoning Profiles in Solving Math Problems Reviewed from Adversity Quotient. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *4*(9), 1213–1221. http://dx.doi.org/10.17977/jptpp.v4i9.12711

Santoso, K. F., Budiarto, M. T., & Sulaiman, R. (2019). Argumentation in Covariational Reasoning: Middle School Student's Solving Covariation Problem with Different Cognitive Style. *International Conference on Science, Technology, Education, Arts, Culture, and Humanity (STEACH)*, *277*, 27–31. https://doi.org/10.2991/steach-18.2019.6

Septiana, A. (2019). Mathematics Adversity Quotient Degree in Students of IAIN Curup Mathematics Tadris Study Program. *Academic Journal of Math*, *01*(01), 51–62. https://doi.org/http://dx.doi.org/10.29240/ja.v1i1.826

Stoltz, P. G. (1997). *Adversity Quotient: Turning Obstacles into Opportunities.* John Wiley & Sons.

Subanji. (2011). *The theory of pseudo-thinking of kovariasional reasoning*. Malang: UM Press.

Sugiyono. (2013). *Qualitative Quantitative Research Methods and R&D*. Bandung: Alfabeta.

Supardi U.S., S. U. S. (2015). The Influence of Adversity Qoutient on Math Learning Achievement. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *3*(1), 61–71. https://doi.org/10.30998/formatif.v3i1.112

Sutini, S., Aaidati, I. F., & Kusaeri, K. (2020). Identifying the structure of students' argumentation in covariational reasoning of constructing graphs. *Beta: Jurnal Tadris Matematika*, *13*(1), 61–80. https://doi.org/10.20414/betajtm.v13i1.374

Umah, U., Asari, A. R., & Sulandra, I. M. (2016). Structure Of Argumentation Reasoning Kovariasional Students Class Viiib Mtsn 1 Kediri. *JMPM: Jurnal Matematika dan Pendidikan Matematika*, *1*(1), 1. https://doi.org/10.26594/jmpm.v1i1.498

Yani, M., Ikhsan, M., & Marwan. (2016). First High School Students' Thought Process In Solving Math Problems Based on Polya Steps Reviewed from Adversity Quotient. *Jurnal Pendidikan Matematika*, *10*(1), 43–58.