

ANALYSIS OF STUDENTS' EPISTEMOLOGICAL BARRIERS TO SYSTEMS OF TWO VARIABLES LINEAR EQUATIONS (SPLDV) VIEWED FROM ADVERSITY QUOTIENT IN JUNIOR HIGH SCHOOL

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Abstract

This study aims to determine students' epistemological barriers in the material system of two-variable linear equations (SPLDV) in terms of Adversity Quotient (AQ). This research method uses descriptive qualitative. The subjects in this study were 6 students who were selected based on their level, namely Adversity Quotient Climber, Adversity Quotient Camper, and Adversity Quotient Quitter. Researchers used questionnaires, written tests and interviews to determine the extent to which subjects had epistemological barriers and Adversity Quotient (AQ). Then, the data analysis techniques used the Winstep application on questionnaires and written tests, then interviews used data reduction analysis, data collection, and drawing conclusions. The results of this study, namely: a) Students who have high epistemological barriers, have epistemological barriers conceptually, procedurally, and operationally; b) Students who have moderate epistemological barriers have operational epistemological barriers; c) Students who have low epistemological barriers, do not have epistemological barriers conceptually, procedurally, and operationally; d) Students with Adversity Quotient Climbers do not yet have low epistemological barriers, as well as Adversity Quotient Campers and Quitters who do not necessarily have moderate and high epistemological barriers; e) Factors that affect the Adversity Quotient and this epistemological barrier is how students understand the material provided by educators. This research can be a source of information and reference for readers.

Keywords: Epistemological Barriers, System of Two Variable Linear Equations, and Adversity Quotient (AQ)

Abstrak

Penelitian ini bertujuan untuk mengetahui hambatan epistemologis siswa pada materi sistem persamaan linear dua variabel (SPLDV) yang ditinjau dari *Adversity Quotient* (AQ). Metode penelitian ini menggunakan deskriptif kualitatif. Subjek pada penelitian ini sebanyak 6 siswa yang dipilih berdasarkan tingkatan, yakni *Adversity Quotient Climber*, *Adversity Quotient Camper*, dan *Adversity Quotient Quitter*. Peneliti menggunakan angket, tes tertulis dan wawancara yang digunakan untuk mengetahui sejauh mana subjek memiliki hambatan epistemologis dan *Adversity Quotient* (AQ). Kemudian, teknik analisis data menggunakan aplikasi *winstep* pada angket dan tes tertulis, kemudian wawancara menggunakan analisis reduksi data, pengumpulan data, dan penarikan kesimpulan. Hasil dari penelitian ini, yakni: a) Siswa yang memiliki hambatan epistemologi tinggi, memiliki hambatan epistemologi secara konseptual, prosedural, dan operasional; b) Siswa yang memiliki hambatan epistemologi sedang, memiliki hambatan epistemologi secara operasional; c) Siswa yang memiliki hambatan epistemologi rendah, tidak memiliki hambatan epistemologi secara konseptual, prosedural, dan operasional; d) Siswa dengan *Adversity Quotient Climber* belum memiliki hambatan epistemologis rendah, begitu juga dengan *Adversity Quotient Camper* dan *Quitter* dimana belum tentu memiliki hambatan epistemologi sedang dan tinggi; e) Faktor yang mempengaruhi *Adversity Quotient* dan hambatan epistemologi ini adalah bagaimana siswa dalam memahami materi yang diberikan oleh pendidik. Penelitian ini dapat menjadi suatu sumber informasi dan rujukan bagi pembaca.

Kata kunci: Hambatan Epistemologi, Sistem Persamaan Linier Dua Variabel, dan *Adversity Quotient* (AQ)

INTRODUCTION

Learning mathematics is an effort made by educators to shape the character of students in creating good mathematical communication skills so that it is easier and more interesting (Zelvina &

Muhammad Yamin, 2023) . But in carrying out learning, of course it is not always easy, sometimes there are still obstacles and result in failure (Nuryami et al., 2022) . Learning difficulties (*learning obstacles*) are conditions of students who are less successful in mastering concepts, principles, or solving problems, even though they have tried to learn them (Cahirati et al., 2020) . Brousseau stated that there are three kinds of *learning obstacles* , namely ontogeny barriers, didactical barriers and epistemological barriers (Rohimah, 2017) . Ontogeny barriers are learning barriers that occur because of the limitations of students' mental readiness to learn (Rahmawati et al., 2021) . Didactical barriers are learning barriers related to the discrepancy in the learning process carried out by an educator (Rizqi Dwi Maharani, Dadan Dasari, 2022) . Epistemological barriers are obstacles caused by limited contexts owned by students so that if new problems arise students will have difficulties (Pauji et al., 2023) . There are two causes of students experiencing learning difficulties, namely external factors and internal factors (Nasution et al., 2022) . The external factors in question are the teacher and the surrounding environment, in this case the teacher is less able to master the material, does not understand the characteristics of students, is less able in active learning techniques, and the limitations of the school environment. While the internal factors referred to are difficulties in developing cognitive aspects in learning mathematics (Alisnaini et al., 2023) .

One of the learning barriers is in solving story problems in solving problems which can be seen in the ability of these students is still low, in this case it is shown by research from (Goddess, 2016) . *Adversity Quotient* is one of the factors that influence a person's ability to exceed potential and effort, survive, and overcome difficulties. This is the expert opinion of Stoltz. This aspect of a person's capacity and performance can be influenced and also predicted by *the Adversity Quotient* and the failure or success of a person can be determined by the *Adversity Quotient* (Shivam & Singh, 2015) .

According to Supardi in (Wahyu Hidayat, 2018) student success in learning depends on how students deal with existing difficulties. Then, how to overcome the difficulties of each student is different, as well as the level of intelligence of students. *The Adversity Quotient* is considered if it is able to support student success in increasing learning achievement, students who have a high *Adversity Quotient* are certainly able to overcome the difficulties they are facing and vice versa with students at a low *Adversity Quotient level* tend to think of difficulties as the end of the journey so that student learning achievement is low (Wahyu Hidayat, 2018) .

Stoltz in (Wahyu Hidayat, 2018) divides 3 types of *adversity quotient* , namely: 1) *Climbers* , individuals who can be relied upon to make changes happen because challenges make them grow; 2) *Camper* , an individual who has limited ability in change, especially big change; 3) *Quitter* , an individual who rejects existing challenges and problems.

Based on this, the researcher wants to know what are the epistemological barriers to students when viewed from the *Adversity Quotient* for junior high school students, so that researchers can describe what epistemological barriers are found in students according to their *Adversity Quotient level*.

METHODS

This type of research uses descriptive qualitative. The purpose of this study was to determine students' epistemological barriers in the material system of two-variable linear equations (SPLDV) in terms of *Adversity Quotient* (AQ). This research method uses a qualitative descriptive method, because the research is carried out in natural conditions which go directly to the data source and the researcher then writes down the data and the facts are collected in the form of words or pictures from numbers (Albi Anggito and Johan Setiawan, 2018) . The researcher analyzed the students' epistemological barriers with the matter of a system of two-variable linear equations in terms of *Adversity Quotient* (AQ) at SMP Negeri 24 Depok, located in West Java, Indonesia.

The selection of research subjects used *purposive sampling* , where the sample was determined with considerations according to research needs (Maharani & Bernard, 2018) . The determination of the subject was carried out based on the results of the distribution of the questionnaire, followed by the distribution of the written test. Based on the results of the questionnaire and written test, it was found that there were six students consisting of 3 male students and 3 female students with different epistemological barriers and *Adversity Quotient* (AQ). The next stage is conducting interview sessions related to epistemological barriers to the six selected students.

This study uses instruments consisting of epistemological barriers and *Adversity Quotient* (AQ) instruments. The instrument for epistemological barriers refers to indicators: 1) Conceptual barriers, lack of understanding of concepts; 2) Procedural obstacles, mistakes in compiling steps, symbols, and elimination-substitution methods; and 3) operational technical obstacles, errors in writing and calculations in answering problems (Maarif et al., 2020) . The *Adversity Quotient* refers to: 1) *Adversity Climber* , students who always try to achieve success; 2) *Adversity Quotient Camper* , students who try to face existing challenges;

3) *Adversity Quotient Quitter* , students who easily get discouraged and stop climbing (Purwasih, 2019) .

Researchers tested the validity of the reliability of the instrument empirically and expert judging. After conducting expert validity, the researcher tested each instrument, then tested the validity and reliability using the *winstep application*. Validity and reliability tests are used to determine whether a research instrument is good or not (Muntazhimah et al., 2020; Sumintono & Widhiarso, 2013) .

The data collection technique used in this study was a questionnaire to find out students' *Adversity Quotient* , a written test to find out students' epistemological barriers, interviews to find out students' epistemological barriers so that the information obtained was complete (Diana & Rofiki, 2020) , and triangulation which is a technique for checking validity of the data or findings of researchers (Sutriani & Octaviani, 2019) .

Data analysis techniques are carried out to manage in a structured manner the results of questionnaires, written tests, and interviews so as to give birth to an actual view, thought, concept (Raco, 2018) . Analysis activities, in the form of: 1) data reduction; 2) Presentation of data; 3) Drawing conclusions (Purnamasari & Afriansyah, 2021) .

RESULTS AND DISCUSSION

Results

The results of students' epistemological barriers in the material system of two-variable linear equations (SPLDV) in terms of *Adversity Quotient* (AQ) are grouped by category: 1) Epistemological barriers of students in terms of *Adversity Quotient* (AQ) *Climber*; 2) Epistemological barriers of students in terms of *Camper's Adversity Quotient* (AQ) ; 3) Epistemological barriers of students in terms of *Adversity Quotient* (AQ) *Quitter* . From these results, each of the 2 students selected according to the above categories. The following is an analysis of students' barriers to the material system of two-variable linear equations (SPLDV) in terms of the *Adversity Quotient* (AQ) and the results of distributing student *Adversity Quotient data* with the *Winstep application*.

P : OK, do you think there is another way to solve question number 1?
 AS1 : I don't think so sir
 Q : Are you sure about your answer in number 1?
 AS1 : Sure sir

Considering the outcomes of of the interview above, it can be seen that subject AS1 was able to understand question number 1 properly and correctly, then was able to explain what was contained in question number 1 even though he only answered determining SPLDV and PLDV, then subject AS1 was only able to use methods that subject AS1 knew course, and subject AS1 is confident with the answer.

AT1 subject

Written Test Results



Figure 3 . Subject Answers AT1

Subject AT1 has not been able to answer the questions correctly and precisely, both in terms of making equations and solving them.

Interview result

Q : Do you understand question number 4?
 AT1 : No sir
 Q : Why don't you understand question number 4?
 AT1 : same as number 3, the form is a matter of story so I don't understand
 P : OK, if you don't understand, can you explain what's in question number 4 that you know?
 AT1 : I can't sir, because I don't understand this
 Q : Is there anything from question number 4 that you don't understand? And why?
 AT1 : Yes sir, I don't know how to solve it
 P : OK, do you think there is another way to solve question number 4?
 AT1 : Maybe there is sir
 Q : Are you sure about your answer in number 4?
 AT1 : No sir

Considering the outcomes of the interview with subject AT1 at number 4, subject AT1 did not understand what was meant by the problem properly because the questions were in the form of story questions, then subject AT1 could not explain what was in the problem and did not know how to solve the problem.

2. Epistemological barriers to students in terms of *Camper's Adversity Quotient (AQ)*.

AR2 subject

Written Test Results

Figure 4 . Subject's Answer AR2

Subject AR2 was able to answer questions correctly. Subject AR2 was able to make equations according to the information contained in the questions correctly and correctly, then subject AR2 was able to determine x and y values by completing elimination to find y values, to find x values not written by subject AR2 but the correct values.

Interview result

Q : Do you understand question number 3?
 AR2 : Got it sir, it's similar to the questions I studied, sir
 P : OK, if you understand, try to explain what is in the question the number 3?
 AR2 : Yes sir, so I determined the number of cows and ducks, then made one equality
 Q : Is there anything from question number 3 that you don't understand? And why?
 AR2 : No sir, because it's similar to the questions you've studied
 P : OK, do you think there is another way to solve question number 3?
 AR2 : Yes sir, because I only understand how to eliminate it, sir
 Q : Are you sure about your answer in number 3?
 AR2 : God willing, I'm sure sir

Considering the outcomes of the interview with subject AR2 on number 3, subject AR2 was able to understand question number 3 properly and correctly, then subject AR2 was able to explain what was contained in question number 3, namely determining the number of cows, ducks, and making equations from known information. Then, subject AR2 had no difficulty in solving question number 3 because it was similar to the problem he was studying.

AS subject2

Written Test Results

2. a = SPLDV karena diketahui sistem persamaan 2 variable
 b = SPLDV karena diketahui sistem persamaan 2 variable
 c = PLDV karena ada 2 variable
 d = PLDV karena ada 2 variable
 e = tidak termasuk SPLDV dan PLDV karena ada pangkatnya
 f = PLDV karena ada 2 variable

Figure 5 . Subject Answer AS2

AS2 subject was able to answer the questions correctly and correctly, AS2 subject was able to show the form of SPLDV and PLDV correctly. In numbers 2a and 2b subject AS2 answered the SPLDV form because it was known that the system of equations was two variables, then 2c, 2d, and 2f subject AS2 answered the PLDV form because there were two variables in the equation, and 2e subject AS2 answered not the form of SPLDV and PLDV because there raised variable.

Interview result

Q	: Do you understand question number 2?
AS2	: I understand sir, the problem is the same as number 1
P	: OK, if you understand, try to explain what is in the question the number 2?
AS2	: Yes sir, so I decided on SPLDV and PLDV
Q	: Is there anything from question number 2 that you don't understand? And why?
AS2	: No sir, the problem is similar to number 1
P	: OK, do you think there is another way to solve question number 2?
AS2	: I don't think so sir
Q	: Are you sure about your answer in number 2?
AS2	: Yes sir

Considering the outcomes of interviews with subject AS2 in number 2, subject AS2 understood what was contained in the question correctly and correctly because the questions were the same as number 1, then subject AS2 was able to say what was known in the problem, namely determining SPLDV and PLDV. Then the AS2 subject was confident with the answer because the AS2 subject mastered this material well and was the same as question number 1.

3. Epistemological barriers to students in terms of *Adversity Quotient (AQ) Quiter*

AS3 subject

Written Test Results

2. Tunjukkan manakah yang merupakan bentuk PLDV atau SPLDV, sertakan alasanmu!

a. $\begin{cases} 4x+y=6 \\ x+3y=9 \end{cases}$ SPLDV

b. $\begin{cases} x-3y=30 \\ x+2y=14 \end{cases}$ SPLDV

c. $8a-b=24$ PLDV

d. $x-2y=10$ PLDV

e. $x^2+y=14$ ~~SPLDV~~

f. $m+n=6$ PLDV

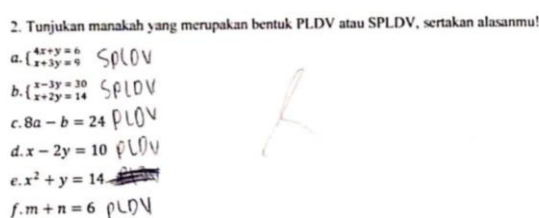


Figure 6 . Subject Answer AS3

AS3 subjects were able to answer the questions correctly and correctly, that is, they could show which form SPLDV and PLDV were. For numbers 2a and 2b subject AS3 indicates the SPLDV form, then numbers 2c, 2d and 2f indicate the PLDV form, and number 2e subject AS3 does not provide an answer.

Interview result

Q	: Do you understand question number 2?
AS3	: I understand sir, the problem is the same as number 1
P	: OK, if you understand, try to explain what is in the question the number 2?
AS3	: Yes sir, so I'm looking for SPLDV and PLDV
Q	: Is there anything from question number 2 that you don't understand? And why?
AS3	: Yes sir, I forgot a bit sir
P	: OK, do you think there is another way to solve question number 2?
AS3	: Maybe there is sir
Q	: Are you sure about your answer in number 2?
AS3	: Sure sir

Considering the outcomes of the interview with subject AS3 on question number 2, subject AS3 was able to understand question number 2 because it was the same as number 1, subject AS3 was able to explain what was contained in the problem, namely looking for SPLDV and PLDV but subject AS3 had difficulty remembering SPLDV and PLDV material. Then, subject AS3 is also sure of the answer.

AT3 subject*Written Test Results*

Figure 7 . Subject Answers AT3

In question number 3, subject AT3 was not able to answer number 3a but in number 3b subject AT3 was able to write the equation according to the information in the question. However, subject AT3 has not been able to determine x and y values using the correct solution method.

Interview result

Q	: Do you understand question number 3? Why?
AT3	: I don't understand, Sir, because I don't really understand this material, Sir about story
P	: OK, if you don't understand, try to explain what is contained on question number 3?
AT3	: look for the number of ducks and cows that I know and shape the similarities
Q	: Is there anything from question number 3 that you don't understand? And why?

AT3	: in solving the problem on this question, the problem is that you don't have enough mastery material
P	: OK, do you think there is a way or not to solve question number 3 the?
AT3	: Maybe there is, sir, but I'm not sure how to do that, sir
Q	: Are you sure about your answer in number 3?
AT3	: not at all, therefore just write down the equation

Considering the outcomes of interviews with subject AT3 on question number 3, subject AT3 did not understand the question but was able to write down the equation because he did not master the material, then subject AT3 was only able to mention looking for the number of ducks and cows, then subject AT3 was not sure about the answer because he did not master the material.

Discussion

Based on the results of the data analysis of students' epistemological barriers in the material system of two-variable linear equations (SPLDV) in terms of *Adversity Qoutient* (AQ), the following information is obtained.

1. Epistemological Barriers to Students in View of Climbers

Conceptual Barriers

In the conceptual barrier indicator, the AS1 subject has no obstacles because the AS1 subject understands the concept of the problem correctly and correctly. This is consistent with analysis by Wawan in (Winarti et al., 2023) which states that conceptual understanding is needed in solving mathematical issues, the same is true of procedural understanding used to solve mathematical problems. Then the subject AT1 has not been able to answer this correctly and correctly due to a lack of comprehension of the concepts in the material so that he can only answer a few statements from the question. This is in line with research (Winarti et al., 2023) which states that some student barriers are due to students not understanding SPLDV material properly and correctly.

Procedural Barriers

On the procedural barriers indicator, the AS1 subject was procedurally able to use the right methods, steps and symbols, due to understanding what is written in the questions, so that the AS1 subject did not have these procedural barriers. This is in line with research conducted by (Talib, nd) which states that conceptual understanding is needed in solving mathematical problems, the same is true of

procedural understanding used to solve mathematical problems. Then, the AT1 subject was procedurally unable to use methods, steps and symbols due to a lack of understanding of the intent of the questions. This is in line with research (Bakar et al., 2019) namely several student errors in SPLDV material between errors in making models and model interpretation.

Operational Barriers

AS1 subjects were operationally able to determine which included SPLDV and PLDV, then were able to carry out calculations properly using the complete formula. Subject AT1 operationally has not been able to carry out calculations properly and correctly so that AT1 is unable to determine the answer to the question. This is in line with research (Perbowo & Anjarwati, 2017) which reveals the importance of mastering algebraic operation techniques because mathematics works a lot with numerical calculations and the use of algebraic operations.

2. Epistemological Barriers of Students in View of Campers

Conceptual Barriers

The AR2 subject was able to understand the information contained in the problem properly and correctly, this can be seen how the AR2 subject was able to write down information on the problem and was able to conceptualize how to solve the problem. Then the AS2 subject was able to explain what was meant in the question correctly and correctly, so that the AS2 subject was able to conceptually determine SPLDV and PLDV. This is in line with research (Aytekin & Şahiner, 2020) which says that understanding a concept and solving procedures is the main foundation in solving various kinds of mathematical problems that can determine the success or failure of a person in solving the problem.

Procedural Barriers

AR2 subjects were procedurally able to determine the appropriate steps, methods, and symbols according to the information provided in the problem. Then the AS2 subject is also able to determine the steps and methods to solve the problem correctly and correctly. This is in line with Sommerhoff and Ufer's research (Maarif et al., 2020) which states that the process of learning mathematics, the use of symbols has a very important meaning because the initial understanding of mathematical

concepts is how to understand the symbols contained in these mathematical concepts.

Operational Barriers

The AR2 subject was operationally able to determine the result of what was asked in the question correctly and correctly, the AR2 subject used the elimination method to answer the question. AS2 subjects were able to determine which included SPLDV and PLDV correctly and correctly. This is in line with research (Perbowo & Anjarwati, 2017) which reveals the importance of mastering algebraic operation techniques because mathematics works a lot with numerical calculations and the use of algebraic operations.

3. Epistemological Barriers of Students in View of Quitters

Conceptual Barriers

The AS3 subject was able to determine which ones included SPLDV and PLDV correctly and correctly, this was because the AS3 subject understood what was meant by the problem, so that the AS3 subject had no conceptual barriers. This is in line with research (Rasnawati et al., 2019) which reveals the importance of understanding algebraic concepts for solving SPLDV. Then, the IR subject did not understand the concept of SPLDV so that the IR subject was not able to answer all the statements correctly and correctly.

Procedural Barriers

AS3 subjects were procedurally able to determine the appropriate steps in answering the question. On the AT3 subject, using the elimination method but not solving it completely, this is because they don't understand how to solve the problem. This is in line with research (Winarti et al., 2023) which states that some student barriers are due to students not understanding SPLDV material properly and correctly.

Operational Barriers

AS3 subjects are operationally able to operate how to differentiate SPLDV and PLDV properly and correctly. However, the AT3 subject has not been able to determine the results of these questions due to limitations in operating. This fits with the research from (Armiyansyah et al., 2021) which says that pupils go through obstacles in understanding the material and identifying problems, unable to solve problems

given in different contexts because students admit that they can only work on linear program questions if they like the inequalities provided. , if it is provided in the form of a story students admit that they cannot finish it.

Based on the explanation above, it can be concluded that students who have high, medium, and low epistemological barriers do not necessarily have an *Adversity Quotient* that fits the category of epistemological barriers above. This is due to how students understand the correct and correct concepts of the material being taught, this is in line with research. This is in line with research (Rasnawati et al., 2019) which reveals the importance of understanding algebraic concepts for solving SPLDV. Then, the IR subject did not understand the concept of SPLDV so that the IR subject was not able to answer all the statements correctly and correctly.

Then not only from a conceptual point of view, but there are students who have procedural obstacles where students also do not understand properly and correctly how to solve problems in questions, either by using the right methods, steps, and symbols. This is in line with research. This is in line with Sommerhoff and Ufer's research in (Maarif et al., 2020) which states that in the process of learning mathematics, the use of symbols has a very important meaning because the initial understanding of mathematical concepts is how to understand the symbols contained in the mathematical concept.

Another obstacle experienced by students in answering questions is in determining the final result. Where there are students who have difficulty operating each of the steps and methods written by the student, causing students to be unable to determine the results of their calculations. This is in line with research (Perbowo & Anjarwati, 2017) which reveals the importance of mastering algebraic operation techniques because mathematics works a lot with numerical calculations and the use of algebraic operations.

CONCLUSION

Based on the results of the above analysis that has been described, it can be concluded that each student has high, medium, and low epistemological barriers. Meanwhile, *Adversity Quotient (AQ)* consists of *Climber*, *Camper*, and *Quitter*. Of the 6 research subjects, it was found that *climbers* had moderate and high epistemological barriers, *campers* with low and medium epistemological barriers, and *quitters* with medium and high epistemological barriers. For students with high epistemological barriers, these students have epistemological

barriers conceptually, procedurally, and operationally. Then, operationally epistemological barriers are owned by students with moderate epistemological barriers. Whereas students with low epistemological barriers do not have barriers both conceptually, procedurally, and operationally. Based on this explanation, it can be concluded that if every student who has an *Adversity Quotient (AQ) Climber* does not mean that he has low epistemological barriers, the same goes for *Camper* and *Quitter Adversity Quotient (AQ)* who have moderate and high epistemological barriers. This is because every student from both *climber*, *camper*, and *quitter* is not necessarily able to understand the material (both in terms of concepts) and operate a system of two-variable linear equations properly and correctly. This research is a study in a junior high school in West Java, so the results cannot be generalized. In other words, it is very possible to obtain different research if the research is carried out with different subjects.

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