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Relationship between Mathematical Communication Ability and Adversity Quotient of Junior High School Students

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ABSTRACT

Students' perceptions of the difficulty of mathematics often influence their mathematical abilities. Students who possess a strong Adversity Quotient (AQ) are likelier to demonstrate improved mathematical abilities, particularly in mathematical communication abilities. This study examines the relationship between mathematical communication ability and students' Adversity Quotient (AQ). The research employed a correlational method, with a sample of 31 ninth-grade students from a junior high school in Bandung City during the 2024/2025 academic year. Data were collected through mathematical communication ability tests and an Adversity Quotient (AQ) questionnaire. The collected data were analyzed in two stages: an Exploratory Data Analysis (EDA), which included normality and linearity tests, followed by Confirmatory Data Analysis (CDA), which used the Pearson correlation test. The results revealed a correlation coefficient of 0.672, indicating a medium-level relationship between students' mathematical communication ability and their Adversity Quotient (AQ). This implies that educational practices should not only focus on cognitive skill development but also incorporate strategies to enhance students' adversity quotient, such as through reflective tasks, problem-based learning, or socio-emotional support, to foster both adversity quotient and mathematical communication ability.

Adanya perspektif siswa tentang sulitnya matematika sering kali berdampak pada hasil kemampuan matematis siswa. Dengan memiliki Adversity Quotient (AQ) yang baik siswa akan memiliki kemampuan matematis yang baik pula, khususnya kemampuan komunikasi matematis. Penelitian ini bertujuan untuk meninjau hubungan kemampuan komunikasi matematis dan Adversity Quotient (AQ) siswa. Penelitian ini menggunakan metode korelasional dengan sampel penelitian 31 siswa kelas IX salah satu SMP di Kota Bandung tahun ajaran 2024/2025. Teknik pengumpulan data dengan memberikan instrumen tes kemampuan komunikasi matematis dan angket Adversity Quotient (AQ). Data yang telah terkumpul dianalisis melalui dua tahap, yaitu Exploratory Data Analysis (EDA) berupa uji normalitas dan uji linearitas; dan Confirmatory Data Analysis (CDA) berupa uji korelasi Pearson. Berdasarkan hasil penelitian diketahui bahwa besaran koefisien korelasi yaitu 0.672, artinya terdapat hubungan antara kemampuan komunikasi matematis dan Adversity Quotient (AQ) siswa dalam kategori sedang. Hal tersebut mengimplikasikan bahwa penyelenggaraan pembelajaran seharusnya tidak hanya fokus pada pengembangan kemampuan kognitif, tetapi juga mengatur strategi untuk meningkatkan adversity quotien siswa, seperti pemberian tugas refleksi, pembelajaran berbasis masalah, atau dukungan sosial-emosional, untuk meningkatkan adversity quotient dan kemampuan komunikasi matematis.

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INTRODUCTION

The rapid advancements in education have significantly influenced the learning objectives that students are expected to achieve, particularly in mathematics. According to National Council of Teachers of Mathematics (2000) the learning objectives of mathematics include problem-solving, reasoning and proof, communication, connection, and representation. Furthermore, 21st-century learning emphasizes the importance of mastering 4C competencies: critical thinking and problem-solving, creativity, communication ability, and collaboration (Fitrah et al., 2022). The ability to communicate mathematical ideas is essential for students. Students can evaluate their understanding through their ability to convey their mathematical ideas (Tong et al., 2021). This ability refers to students' capacity to articulate and communicate their understanding of mathematical concepts, facilitating the resolution of mathematical problems both orally and in writing (Anisa et al., 2023). Students' ability to communicate mathematical ideas is strongly influenced by their intelligence (Triana et al., 2019). Mathematical communication ability can describe students' thinking processes and understanding of mathematical concepts. Based on this description, mathematical communication ability can help students achieve learning objectives.

Previous studies indicate that students generally struggle to develop their mathematical abilities to a high level, particularly in mathematical communication ability (Gardenia et al., 2021). The development of mathematical communication ability remains a critical challenge, as only one out of three subjects was found to meet the required indicators for this ability (Rohid et al., 2019). Furthermore, research by Kamid et al. (2020) showed that there were still incomplete steps or procedures in working on mathematical communication ability problems. In research Uyen et al. (2021) found that students face significant limitations in both oral and written mathematical communication, many students expressed frustration with visual representations of mathematics, as they are more accustomed to solving problems in arithmetic form. Similarly, (Maulyda et al., 2020) obtained the results that there are still students who cannot communicate their mathematical ideas well, this can be seen from the students' low written mathematical communication ability. Research by Sekaryanti et al. (2022) revealed that students with low mathematical communication ability could not solve the mathematical problems given, where most of the answers provided by students were wrong. Collectively, these findings need for greater focus on improving students' mathematical communication abilities, which remain generally weak.

The limited level of students' mathematical communication ability can be attributed to the challenges they face when attempting to solve questions related to mathematical communication. These difficulties hinder their overall performance and ability to communicate mathematical ideas effectively. According to (Wandari & Anggara, 2021), these difficulties include issues with understanding mathematical concepts, performing operations (Hariati et al., 2022; Sibarani et al., 2022), visualizing mathematical ideas (Saputra et al., 2022), and interpreting mathematical ideas (Mardiani, 2021). Addressing these challenges in mathematics learning, particularly in solving mathematical communication problems, requires students to possess the intelligence and resilience to confront and overcome difficulties, which is encapsulated in the concept of adversity quotient. The adversity quotient refers to an individual's capacity to respond to and navigate challenges, difficulties, and obstacles encountered while striving to achieve success (Chadha, 2021; Juwita et al., 2020). Adversity quotient is an essential ability that a person must have in dealing with difficulties to achieve the expected goals (Stolz, 2000). The adversity quotient represents an individual's intelligence and ability to survive various challenges and problems (Rani et al., 2020). In summary, the adversity quotient represents an individual's capacity to respond effectively to challenges and obstacles to achieve their goals. Its development is essential for helping students navigate the complexities of learning mathematics and improving their mathematical communication abilities.

The adversity quotient consists of four dimensions: Control, Origin and Ownership, Reach, and Endurance (Chadha, 2021; Mz et al., 2021; Stolz, 2000). By using these four dimensions, students' ability to deal with difficulties can be measured and grouped into adversity quotient categories. Adversity quotient can be classified into three primary categories: quitters, campers, and climbers. Quitters, where students choose to retreat and give up on working on these problems; campers, which are students who try to work on these problems only as much as they can; and climbers, which are students who try to work on these problems and find the best solution to problems that are considered difficult (Stolz, 2000). Previous research found that students need a good adversity quotient to improve their learning achievement (Hastuti et al., 2018). Therefore, students who possess an adversity quotient at the climber level are likely to navigate challenges in learning mathematics more effectively. They are expected to

demonstrate superior mathematical communication skills compared to their peers who have adversity quotients at the camper or quitter levels, who may struggle more when faced with similar difficulties.

Although both mathematical communication and adversity quotient have been studied separately, research exploring the relationship between the two, particularly in the context of learning statistics, is still limited. Therefore, this study aims to investigate the relationship between students' mathematical communication ability and their adversity quotient in the context of statistical topics. The mathematical communication ability examined in this study focuses on written mathematical communication within the context of statistical material.

METHODS

This correlational research examines the relationship between mathematical communication ability and the adversity quotient among junior high school students. The study's population comprised ninth-grade students from a junior high school in Bandung City during the 2024/2025 academic year. This study employed a purposive sampling technique to select 31 students who had previously studied statistical topics. The selection was based on the consideration that the research instrument focused on statistical content, requiring participants to have prior exposure to the subject matter. By selecting students with relevant background knowledge, the study ensured that the data collected would be valid for measuring their understanding of statistical concepts. This approach allowed the researchers to obtain a sample that met specific criteria aligned with the objectives of the study. Data collection involved administering three expert-validated mathematical communication tasks and a questionnaire consisting of 40 statements measuring the adversity quotient. The indicators used to assess mathematical communication ability in this study are based on the framework developed by National Council of Teachers of Mathematics (2000), which includes: 1) Ability to communicate, present, and visualize mathematical ideas orally and in writing; 2) The ability to comprehend, interpret, and evaluate mathematical concepts expressed in oral, written, or other visual forms; 3) The ability to use mathematical terms, notations, and structures to present ideas and explain their relationship to situational models. The questionnaire used in this study was adapted from (Fahrani, 2023) and included indicators of the adversity quotient as defined by Stolz (2000). These indicators are: 1) Control, where students have strong control to control themselves in difficulties in math learning; 2) Origin & Ownership, where students can learn from mistakes in dealing with math problems without regret; 3) Reach, where students know the limits that can be reached by themselves in understanding the material and solving math problems; 4) Endurance, this refers to students' ability to acknowledge that the challenges they face, along with the underlying factors that contribute to difficulties in the mathematics learning process, are temporary in nature and can be effectively overcome with persistence and effort.

The data analysis process was conducted in two stages: Exploratory Data Analysis (EDA) and Confirmatory Data Analysis (CDA). Exploratory Data Analysis (EDA) this involves conducting a normality test and a linearity test, while Confirmatory Data Analysis (CDA), if normality and linearity are met, the Pearson correlation test is used with the correlation category by Oranpattanachai (2023) as in Table 1.

Table 1. Pearson Correlation Coefficient

Correlation Coefficient Interval	Correlation Coefficient Interpretation
$\|0.81 - 1.00\|$	Strong
$\|0.51 - 0.80\|$	Medium
$\|0.21 - 0.50\|$	Low
$\|0.1 - 0.2\|$	Very Low
$\|0.00\|$	No Correlation

The students' mathematical communication abilities were classified according to the categorization framework proposed by Arikunto (2013) in Table 2.

Table 2. Categorization of Mathematical Communication Ability

Value Criteria	Category
$X \geq \bar{x} + SD$	High
$\bar{x} - SD < X < \bar{x} + SD$	Medium
$X \leq \bar{x} - SD$	Low

The students' adversity quotient were classified according to the categorization framework proposed by Hastuti et al. (2018) in Table 3.

Table 3. Adversity Quotient Categorization

Adversity Quotient Score	Category Adversity Quotient
$135 - 200$	Climber
$60 - 134$	Camper
≤ 60	Quitter

RESULTS

Students' Adversity Quotient

The adversity quotient questionnaire used in this study was designed to assess four key indicators: control, origin and ownership, reach, and endurance. A total of 31 students participated by completing the questionnaire. The data obtained from their responses were analyzed and subsequently categorized into two distinct levels of adversity quotient: camper and climber. These levels reflect the different capacities of students to face challenges, with campers exhibiting moderate resilience and persistence, while climbers demonstrate higher levels of determination and the ability to overcome obstacles effectively. The findings derived from the students' questionnaire are displayed in Table 4 below.

Table 4. Category of Student' Adversity Quotient

Adversity Quotient Score	Adversity Quotient Classification	Number of Students
$135 - 200$	Climber	9
$60 - 134$	Camper	22
≤ 60	Quitter	0

Based on Table 4, 22 students are in the camper category with adversity quotient scores between 60-134. Meanwhile, nine students who are classified within the climber category, with a score of 135-200, which reflects their ability to keep trying to face challenges. There were no students who belonged to the quitter category (score ≤ 60), indicating that there were no students who gave up on the challenge. The average adversity quotient of 126 with a standard deviation of 9.5 indicates that most students have a fairly good level of emotional resilience, although there is still room for improvement, especially on specific indicators.

Students' Mathematical Communication Ability

Students' mathematical communication abilities were assessed across three distinct aspects: writing, drawing, and mathematical expression. Writing refers to the skill of expressing mathematical ideas with clarity and accuracy through written communication. Drawing encompassed the capacity to represent mathematical concepts visually through diagrams, graphs, or other illustrative methods. Mathematical expression evaluated the students' proficiency in using symbols, equations, and formal mathematical language to convey their understanding. The results of this assessment were classified into three categories: low, medium, and high. The results are presented in Table 5 below.

Table 5. Category of Students' Mathematical Communication Ability

Mathematical Communication Ability Score	Classification of Mathematical Communication Ability	Number of Students
$\overline{X} \geq 87.51$	High	3
$64.29 \leq \overline{X} < 87.51$	Medium	21
$\overline{X} < 64.29$	Low	7

Based on Table 5, 7 students were in the low mathematical communication ability category, 21 students were in the medium category, and only three students were in the high category. The average score of students' mathematical communication ability is 75.9 with a standard deviation of 11.61. This means that most students have sufficient mathematical communication ability. However, some students need further action to improve

mathematical communication, especially in conveying mathematical ideas through writing, drawings, and mathematical expressions.

Relationship between Mathematical Communication Ability and Adversity Quotient

Relationship between students' mathematical communication ability and their adversity quotient was analyzed using the Pearson correlation test. Prior to performing the correlation analysis, prerequisite tests were conducted to ensure the initial assumptions were met. Both the prerequisite tests and hypothesis testing were conducted at a 95% confidence level ($\alpha = 0.05$). The prerequisite tests consisted of a normality test and a linearity test, while the hypothesis was assessed using the Pearson correlation test. The results of the normality test are provided in Table 6 below.

Table 6. Normality Test Results of Mathematical Communication Ability and Adversity Quotient Data

	Statistic	Df	Sig.
Mathematical Communication Ability	0.933	31	0.54
Adversity Quotient	0.963	31	0.359

The Shapiro-Wilk test was used to assess normality, as the sample size in this study was fewer than 50 students. According to Table 6, the significance values for both students' mathematical communication ability and their adversity quotient exceed 0.05, indicating that the data for these variables are normally distributed. Following this, a linearity test was conducted to explore the potential linear relationship between mathematical communication ability and students' adversity quotient. This test aimed to determine whether a consistent and proportional association exists between these two variables. The results of the linearity test are presented in Table 7 below for further examination.

Table 7. Linearity Test Results of Mathematical Communication Ability and Adversity Quotient

			Sum of Squares	df	Mean Square	F	Sig.
Adversity Quotient* Mathematical Communication Ability	Between Groups	(Combined)	451.855	8	56.482	4.04	0.004
		Linearity	342.684	1	342.684	24.538	0.000
		Deviation from Linearity	109.171	7	15.596	1.117	0.388
	Within Groups		307.236	22	13.965		
	Total		759.091	30			

Table 7 states that the linearity of mathematical communication ability and adversity quotient is 0.388 greater than 0.05. This means that mathematical communication ability and adversity quotient have a linear relationship. Furthermore, hypothesis testing was conducted to test the strength of the relationship between mathematical communication ability and adversity quotient with the Pearson correlation test. The results of the Pearson correlation test are displayed in Table 8 below.

Table 8. Pearson Correlation Test Results

		Mathematical Communication Ability	Adversity Quotient
Mathematical Communication Ability	Pearson Correlation	1	0.672**
	Sig. (2-tailed)		0.000
	N	31	31
Adversity Quotient	Pearson Correlation	0.672**	1
	Sig. (2-tailed)	0.000	
	N	31	31

Table 8 states that the magnitude of the relationship between mathematical communication ability and adversity quotient is 0.672, with a significance of 0.672. $0.000 < 0.05$. A significant relationship exists between mathematical communication ability and students' adversity quotient. As shown in Table 9, the coefficient of determination between these two variables is 45.1%. This indicates that their adversity quotient can explain 45.1% of the variance in students' mathematical communication ability, while other factors influence the remaining 54.9%.

Table 9. Coefficient of Determination

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.672	0.451	0.433	8.74587

DISCUSSION

Students' Adversity Quotient

The adversity quotient is a key factor that greatly impacts students' future success (Handayani et al., 2023). According to the results of the data analysis, the students' adversity quotient falls within the camper category. Students categorized as campers tend to put forth their best effort when solving problems. Consistent with findings by Juwita et al. (2020) students with a camper category adversity quotient have quite good fighting power in learning mathematics, although they will give up if faced with more complex problems. This often prevents students from achieving their expectations, because students with a camper adversity quotient usually give up when what they face is outside their comfort zone. This was evident in the students' answers, where most of the students with adversity quotient campers made mistakes in working on problems that contained the third indicator of mathematical communication ability tested. It is different for students who have an adversity quotient climber category.

Students classified in the climber category of adversity quotient are distinguished by their consistent effort to tackle problems and their strong determination to identify the most effective solutions. This is reflected in their responses, as students in this category consistently demonstrate a high level of proficiency by successfully meeting all the indicators of mathematical communication ability. Additionally, climbers demonstrate a strong willingness to tackle challenges, even when these problems push them beyond their comfort zone, showcasing their resilience and commitment to overcoming obstacles. These results are similar with the research Hidayat et al. (2018) that students with an adversity quotient in the climber category tend to re-examine the results of their work so that the work they do is considered correct.

Students' Mathematical Communication Ability

The findings of the study indicate that students' mathematical communication abilities are categorized as medium. Students in this category successfully met two out of the three indicators of mathematical communication ability. However, some students encountered difficulties, leading to minor errors when addressing problems related to the second indicator of mathematical communication ability. Students have difficulty solving problems that apply mathematical concepts, where students experience mistakes when choosing the concepts to be used in solving problems. Similarly, Ikhsan et al. (2020) found that students with medium communication ability often have difficulty in understanding problems which results in students making mistakes when applying concepts using mathematical expressions. In addition, research (Viyani et al., 2022; Yuniarti & Putra, 2021) showed that students with adversity quotient camper experienced errors in applying concepts to the answers given.

The underdevelopment of students' mathematical communication ability highlights the need for targeted efforts to enhance this skill. In agreement with the findings Dina et al. (2019) it is essential to improve students' mathematical communication abilities by providing a range of questions that vary in difficulty and complexity. Students who demonstrate strong mathematical communication ability tend to exhibit greater ease in solving mathematical problems (Samawati & Ekawati, 2021).

Relationship between Mathematical Communication Ability and Adversity Quotient

The data presented in the results section show that the dataset is both normally distributed and linear. Once the initial assumptions were satisfied, the correlation coefficient between mathematical communication ability and adversity quotient was found to be 0.672. This value indicates a medium positive correlation, implying that students with a higher adversity quotient are more likely to exhibit stronger mathematical communication abilities. In other words, students with a higher adversity quotient tend to exhibit stronger mathematical communication abilities.

The findings of this research are consistent with the study conducted by Rahmawati (2023) that climbers students (high AQ) solved problems and met all indicators, campers students solved problems but met only verbal and mathematical expression indicators, while quitter students (low AQ) could not solve problems and met only the visual representation indicator. Similarly, study by A.Rofiq (2022) which found that students categorized as climbers, with a higher adversity quotient, tend to exhibit better communication abilities compared to those in the camper category. Furthermore, the research by Prayogo et al. (2024) revealed that students in the camper category show stronger communication abilities than those in the quitter category. Additionally, the coefficient of determination of 45.1% suggests that other factors also influence students' mathematical communication ability and adversity quotient.

CONCLUSION

The results revealed a medium positive relationship between students' mathematical communication ability and their adversity quotient. The correlation coefficient was found to be 0.672, which falls within the medium category. This suggests that as students' adversity quotient improves, their mathematical communication ability also tends to improve, and vice versa. Furthermore, the coefficient of determination was calculated to be 45.1%, indicating that 54.9% of other factors such as technology-based learning models that may influence students' adversity quotient and mathematical communication ability (A.Rofiq, 2022; Ismawati, 2024).

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