

## Analysis of Students' Mathematical Communication in Solving AKM Problems by Students with Varying Anxiety Levels

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### Keywords:

mathematical communication; AKM;  
mathematical anxiety

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### Abstract

This qualitative study analyzes students' mathematical communication while solving minimum competency assessment-type questions concerning their levels of math anxiety. The study involved 27 students in class VII B at Junior high school, with six junior high school students as subjects. Data were gathered through math anxiety questionnaires, tests with minimum competency assessment question types, and student presentation assessment sheets. The completed questionnaire was used to select subjects for the tests and presentations. The test sheet contains questions on the AKM type of flat material and three description questions. The data were analyzed through reduction, presentation, and conclusion stages. Findings indicate that students' math anxiety levels were high, medium, and low, with moderate anxiety being the most common. While no students showed low mathematical communication skills, three students were found to have average skills, and three students demonstrated high mathematical communication abilities.

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Putri, F., N., W., Cholily, Y., M., & Zukhrufurrohmah. (2023). Analysis of Students' Mathematical Communication in Solving AKM Problems by Students with Varying Anxiety Levels. *Mathematics Education Journal*, 7(2), 225-238. DOI : 10.22219/mej.v7i1.28055

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## INTRODUCTION

The mathematical communication skills of junior high school students have consistently been categorized as low for three consecutive years (Syafina & Pujiastuti, 2020; Maharani & Ramlah, 2021; Zaditania & Ruli, 2022). Mathematical communication refers to a student's ability to express mathematical ideas through writing and oral communication (Ali Rasyid, 2019). Hidayati & Armiati (2022) state that mathematical communication is a critical skill required to convey mathematical information in the form of ideas, and reasoning, and to prove mathematics with sentences, symbols, tables, and diagrams. It is essential to master this mathematical communication skill because it is used as a means of interaction between teachers and students, and mathematics is a social activity in learning (Deswita et al., 2018). The effectiveness and success of learning activities are greatly influenced by this communication process (Masdul, 2018).

Rahmin et al. (2022) evaluated students' mathematical communication skills by assessing their ability to understand problems, plan problem-solving strategies, solve problems, and analyze their results. The Minimum Competency Assessment

(AKM) is a suitable test to measure these skills, as it is contextual, stimulates critical thinking, and measures problem-solving competence through varying question formats (Patriana et al., 2021). The AKM test results help describe students' written and oral mathematical communication abilities.

When faced with tests or exams, many students experience anxiety and nervousness, particularly in math exams. Math anxiety, as defined by Dreger and Aiken, is an emotional response characterized by symptoms that appear simultaneously in arithmetic and mathematics (Baloğlu & Balgalmış, 2010). Emotional disturbances (such as mood and feelings) are common indications of anxiety, according to Holmes (1991). Students may feel anxious, afraid, tense, nervous, and insecure, which can impede their ability to perform well in math. Some students view math exams as problematic due to their feelings of shame when they receive poor grades, as well as their uncertainty regarding their preparedness for the exams (Disai et al., 2017). Anxiety in mathematics is not normal or acceptable because it can lead to difficulties and even phobias in learning activities, which can hurt learning outcomes and student achievement in mathematics (Anita, 2014).

Math anxiety can be caused by the belief that math is difficult, resulting in low concentration levels, doubts about one's abilities, difficulty memorizing formulas, and not understanding how to apply them when answering questions. To measure math anxiety in Indonesia, Desai et al. (2017) recommend using a culture-specific measuring tool for mathematics subjects. To define math anxiety, A'ini's (2021) questionnaire, which includes Holmes' (1991) definition, can be adapted. The indicators of math anxiety are:

Table 1 Indicators of Mathematical Anxiety

Aspect	Indicator
Emotion (mood/feelings)	Scared
	Nervous and Tense
	Worried
Motor	In a hurry
	Trembling
Cognitive	Difficulty Concentrating
	Confused and unable to make a decision
	Hard Time Recalling
Somatic	Increase In Heartbeat
	Sweating easily

Source (A'ini, 2021)

According to Winardi et al. (2019), there is a strong correlation between mathematical communication and math anxiety. Students with higher levels of math anxiety tend to have weaker mathematical communication skills, and vice versa. This idea is supported by Zahro & Purwaningsih (2018), who state that math anxiety can significantly impact students' abilities regarding exam questions. When students feel anxious about math, it can interfere with their learning and negatively affect their performance. Conversely, having a healthy level of anxiety can positively impact student achievement. The mathematical communication indicators used in this study were adopted by Rahmin et al. (2022).

Table 2 Mathematical Communication Indicators

Written Mathematical Communication Indicators	Oral Mathematical Communication Indicators
Students understand the questions given and write down what is known and asked from the questions given.	Students understand the questions given and explain what is known and asked from the questions given.
Students write down a problem-solving plan to solve the given problem.	Students explain the problem-solving plan to solve the given story problems.
Students write down the steps and plans that have been made to solve the given problem.	Students explain the steps and plans that have been made to solve the given problem.
Students read again and write conclusions from the problems that have been done.	Students re-read their work and explain the conclusions of the problems that have been done.

Through various studies, it has been found that there is limited research on the written and verbal aspects of mathematical communication, particularly when it comes to solving AKM-type questions and the anxiety levels of students. Thus, this study aimed to examine the communication abilities of students in both written and oral forms when solving AKM-type questions concerning their math anxiety levels.

## RESEARCH METHOD

This study utilized a qualitative approach to describe the research subject and address relevant phenomena. Conducted at SMP Brawijaya Smart School in Malang, the study included 27 participants, with 6 of them being in class VII B. The research occurred between March 8-15, 2023, during the 2022/2023 academic year semester.

Data collection was conducted through a questionnaire comprising 29 statements related to mathematical anxiety, which all 27 students completed. Based on the questionnaire results, 2 students were selected from each level of mathematical anxiety to complete a test consisting of AKM-type questions and 3 description questions on flat shape material. Finally, students were asked to create presentations based on their test results. The data collected were analyzed through three stages: data reduction, data presentation, and conclusion.

## RESULTS AND DISCUSSION

### a) Students' Mathematics Anxiety Level

The table below presents the results of a questionnaire answered by 27 students, indicating the level of math anxiety among them.

Table 3 Level of Students' Mathematics Anxiety

No	Math Anxiety Level	Frequency	Percentage (%)
1.	Didn't Experience	0	0
2.	Low/mild	8	30
3.	Moderate	11	40
4.	High	8	30
5.	Very High	0	0
Total		27	100

After analyzing the questionnaire responses of 27 students, it was found that only 3 students had reached 3 levels of math anxiety. Among them, 8

students had low math anxiety and tended to feel worried emotionally if they received a poor grade in math. 11 students had moderate math anxiety and tended to feel worried, tense, and afraid emotionally, as well as experience physical symptoms such as a faster heart rate when solving math problems in front of the class or answering questions. 8 students had high math anxiety and exhibited anxiety in all aspects, including emotional aspects such as worry, fear, nervousness, and tension, motoric aspects such as shaking when solving math problems in front of the class or receiving test questions from the teacher, cognitive aspects such as confusion and inability to make decisions when solving questions, and somatic aspects such as a faster heart rate during math-related tasks in class.

b) Mathematical Communication Skills of Students with High Math Anxiety

Students in the first and second years of study who experience high levels of math anxiety received test results and gave presentations at a moderate level of mathematical communication. However, there are differences in how well each student met the criteria for mathematical communication at the same level. Here is a breakdown of each student's mathematical communication:

no 2  
Diketahui: tinggi dinding 4m lebar 2m  
lebar poster 20cm panjang poster 40cm dengan harga 35.000/mtr  
Ditanya: berapa poster yang di perlukan untuk memenuhi 2 sisi tembok  
berapa total biaya  
Jawab A: 200 lembar  
Jawab B: Rp. 7.000.000  
Kesimpulan: A setiap sisi membutuhkan 100 maka jika 2 200 lembar  
B  $35.000 \times 200 = 7.000.000$

Figure 1 Answers to S1 Test Results

According to the test results and presentations, the bachelor's degree achieved a score of 16 for written mathematical communication and a score of 20 for oral mathematical communication. This indicates that the bachelor's degree has a moderate level of mathematical communication in both writing and speaking. While S1 can perfectly fulfill indicators 1 and 4 in mathematical communication, they have not fulfilled indicators 2 and 3 because they did not provide information about the stages of working on the questions and how to solve them. On the math anxiety questionnaire, S1 reported experiencing high levels of anxiety. Specifically, they had difficulty determining formulas, making decisions, and recalling material taught by the teacher. Their emotional reaction was nervousness, tension, and worry. During presentations, S1 exhibited rushed and nervous behavior. The same anxious behavior was also observed during the test as they seemed agitated and moved their legs frequently.

② a = Diketahui = lebar dindingnya lebar 2m dan tinggi 4m.  
Ditanya = Hitung berapa banyak poster yang dibutuhkan untuk memenuhi 2 sisi dinding kamar.  
Dijawab =  $2 \times 4 = 8 \text{ m}^2$   
 $8 \text{ m}^2 = 800 \times 100 \text{ cm}^2$  → didapatkan dari 2m dan 4m yang diubah menjadi cm  
 $\frac{80000}{200 \times 100} = 400$  poster yang dibutuhkan  
b = Diketahui = Harga poster per lembar 35.000.  
Ditanya = Berapakah biaya yang dibutuhkan untuk membeli poster?  
Dijawab = Poster yang dibutuhkan = 400, harga = 35.  
 $400 \times 35 = 14.000$

Figure 2. Answers to the S2 Test Results

After analyzing the test results and presentations, it was determined that S2's total score for written and oral mathematical communication was 16. This puts their Master's degree at a moderate level for both forms of communication. These results suggest that S2's mathematical communication skills are also at a moderate level. To improve their skills, S2 should focus on meeting the mathematical communication indicators for both writing and oral presentations. Unfortunately, there were several deficiencies found in their work on the questions and presentations that prevent them from meeting all of the criteria for mathematical communication indicators.

Based on the math anxiety questionnaire, it was found that S2 had high math anxiety. Emotionally, the student felt worried about receiving poor grades in math, nervous when asked to solve problems in front of the class, and fearful when the teacher asked questions. Physically, the student trembled when asked to come to the front of the class and their heart rate increased when answering questions. In terms of cognition, the student needed help understanding formulas and making decisions. During a presentation of their work, the student appeared nervous and hesitant to explain their answers. However, during tests, there were no observable anxious reactions as S2 remained calm.

c) Mathematical Communication Skills of Students with Moderate Math Anxiety

Students in S3 and S4 with moderate math anxiety achieved medium to high levels of mathematical communication in their test results and presentations. Notably, there were significant differences between the levels of mathematical communication achieved by S3 and S4 students with the same level of math anxiety. The results of their mathematical communication levels are described below:

3) a). Ditetahui : P dan l rangan

Kt. u	4	2 d
Kt. a	9+4	3+3
Rt	5	3
Df.	4	3
Gm	5	3
K m	3+3.0	2+2
G	3	2

Ditanya : p & l bahan

Jawab :

9	2
8	5
5	3
4	3
5	3
5	4
3	2
35	25

Jadi bahan yang dibutuhkan dengan p & l berturut 35 m & 25 m

b) Jawab : kurang ideal, terlalu sempit

Figure 3 Answers to the S3 Test

Based on the test results and presentations, it appears that the doctoral degree's mathematical communication skills scored a moderate 23 in both written and oral communication. However, there were issues with S3's understanding of the purpose and intent of the questions, which affected their ability to answer them. As a result, S3 did not meet indicators 2, 3, and 4 of mathematical communication, both in writing and orally. It's important to note that when looking for the area of a building, one should focus on estimating the land required to build a house, rather than solely the length and width of the building.

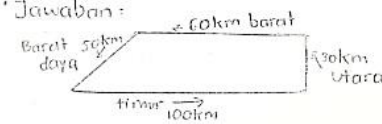
The student's level of math anxiety is moderate and is related to their ability to communicate mathematically. Anxiety is evident in different aspects, including the emotional aspect, where students feel anxious and worried about making mistakes in math and when presenting in front of the class. Students also display anxiety in the motoric aspect by rushing through math problems and making careless errors. In the cognitive aspect, students struggle to concentrate during math learning activities. In the somatic aspect, students may sweat when working on math problems. Anxiety is also evident during presentations, where students may stutter or repeat themselves. S3, for example, displayed anxiety by fidgeting and turning around while working on questions.

1) a. Diketahui :

- Barat : 60 km
- Barat daya : 50 km
- Timur : 100 km
- Utara : 30 km

Ditanya : nama bangun datar yang sesuai skema / rute pelayaran kapal

Jawaban :



Jadi bangun datar yang sesuai skema / rute pelayaran kapal adalah trapesium

b. Diketahui :

- jarak kapal ikan & jumlahnya
- Barat : 60 km, 2 ton = 2000 kg
- Barat daya : 50 km, 500 kg
- Timur : 100 km, 1 ton = 1000 kg
- Utara : 30 km

Ditanya : total jarak kapal berlayar (km) dan total ikan yang berhasil ditangkap (kg)

Jawaban : Total jarak kapal :  $60 + 50 + 100 + 30 = 240$  km

total seluruh ikan :  $2000 \text{ kg} + 500 \text{ kg} + 1000 \text{ kg} = 3500 \text{ kg}$

Jadi jarak total kapal berlayar adalah 240 km dan total ikan yang berhasil ditangkap dalam satuan kg adalah 3500 kg

Figure 4 Answers to S4 Test Results

According to the test results and presentations, S4 demonstrated strong skills in both written and oral mathematical communication, scoring 32 and 31 respectively. Although S4 performed well and met all four indicators for mathematical communication, the scores indicate that there is still room for improvement to reach perfection. The predetermined aspects of mathematical communication were evaluated through test questions and presentations.

According to the student math anxiety questionnaire, students experience a moderate level of math anxiety. Emotionally, they feel worried and anxious when they receive poor grades in math. Physically, their hearts beat faster when they are asked to answer questions in front of the class or engage in question-and-answer sessions with the teacher. For example, S4 displayed nervousness and haste during a presentation but appeared relatively calm while working on math problems.

d) Mathematical Communication Skills of Students with Low Math Anxiety

Students in S5 and S6 who experience math anxiety received test scores and presentations with a high level of mathematical communication. The mathematical communication levels of the S5 and S6 students are described as follows:



3. Diket: Ukuran minimal masing-masing ruangan bagi keluarga adalah

Ruangan	Panjang (m)	Lebar (m)
Kamar tidur utama	4	4
Kamar tidur anak	3	3
Kamar tidur tamu	5	3
Ruang tamu	3	3
Ruang makan	4	3
Dapur	5	3
Garasi mobil	3	2
Kamar mandi	3	2
Gudang	3	2

Tabel tersebut memiliki gambaran rumah untuk 2-5 orang

Ditanya: a) Pak Andre ingin membangun rumah untuk dituni keluarganya. Pak Andre tidak butuh kamar tamu dan ruang makan. Rumah tersebut hanya ada 2 kamar mandi. Sesuai daftar rumah ideal, maka berapa minimal lahan yg harus disiapkan Pak Andre?  
b) Apakah lahan seluas  $12\text{m}^2$  cukup ideal untuk membuat kamar tidur utama? Jelaskan!

Jawab: a)

kamar tidur utama	$= 4 \times 4$	$= 16$
kamar tidur anak	$= 4 \times 3 \times 2$	$= 24$
Ruang tamu	$= 5 \times 3$	$= 15$
Dapur	$= 4 \times 3$	$= 12$
Garasi	$= 5 \times 3$	$= 15$
Kamar mandi	$= 3 \times 2 \times 2$	$= 12$
Gudang	$= 3 \times 2$	$= 6$
		$\frac{6}{100\text{m}^2}$

b) Tidak karena Luas kamar tidur utama adalah  $16\text{m}^2$  bukan  $12\text{m}^2$   
Jadi a) adalah  $100\text{m}^2$  dan b) adalah tidak karena ukuran minimal adalah  $16\text{m}^2$

Figure 5. S5 test answer results

After reviewing the test results and presentations, it was found that S5 scored 35 in written mathematical communication and 36 in oral mathematical communication. This indicates that S5 is highly skilled in mathematical communication, meeting all four communication indicators through both written and oral means. S5's scores were close to perfect. It appears that S5 focuses on predetermined mathematical communication aspects when completing tests and presentations.

According to the math anxiety questionnaire, the level of anxiety felt by students was low. However, students did experience anxiety in different aspects. Emotionally, they felt worried about receiving a bad grade in mathematics. In terms of motor skills, they felt rushed when solving math problems. During the presentation, no visible anxiety was observed. However, when working on certain questions, S5 appeared nervous and made several movements, indicating anxiousness.



2. a. Diketahui = Luas dinding =  $400\text{cm} \times 200\text{cm} = 80000\text{ cm}^2$   
Luas poster =  $20\text{cm} \times 40\text{cm} = 800\text{ cm}^2$

Ditanya = Banyak poster yang dibutuhkan untuk memenuhi 2 sisi dinding kamar

Cara = Luas dinding  $\div$  Luas poster  $\times 2$  (yang dipenuhi 2 dinding)  
 $80.000 \div 800 = 100 \times 2 = 200$

kesimpulan = Banyak poster yang dibutuhkan untuk memenuhi 2 sisi dinding kamar sebanyak 200 poster

b. Ditanya = biaya yang dibutuhkan untuk membeli poster

Diket = 1 poster seharga 35.000  
poster yang digunakan = 200

cara = harga poster  $\times$  jumlah poster yang dibutuhkan  
 $35.000 \times 200 = 7.000.000$

kesimpulan = Biaya yang dibutuhkan untuk membeli poster adalah 7.000.000

Figure 6. S6 test answer results

Based on the results of the test and presentation, the S6 received a score of 29 for written mathematical communication and 30 for oral mathematical communication, which places it in the category of high-level mathematical communication. Although the S6 performs well in almost all mathematical communication indicators, its test and presentation scores indicate that there is still room for improvement in its mathematical communication abilities. While the S6 meets all four indicators, it does not fully meet the criteria.

The student's math anxiety questionnaire revealed low levels of math anxiety overall. However, students experienced emotional and physical anxiety symptoms when explaining answers to the class and working on questions with a time limit. During the S6 presentation, the student had no visible anxiety, as they explained their answers fluently, coherently, and precisely while appearing relatively calm.

Based on the results of filling out the questionnaire from 27 students, it was found that 8 students with low math anxiety levels, 11 students with moderate anxiety levels, and 8 students with high anxiety levels. This aligns with Hajerina et al.'s (2023) research, which found 5 students with low math anxiety, 12 with moderate math anxiety, and 6 with high math anxiety. The results of the anxiety questionnaire indicated that students experienced moderate levels of math anxiety, which was influenced by personal factors such as emotions, learning interest, and mathematical abilities, as well as environmental factors like pressure from family, school, and society. Astiati and Ilham's (2023) research also supports the notion that environmental factors contribute to math anxiety, as students can feel depressed by the monotonous nature of math learning, leading to boredom. Furthermore, students may find math scary due to its emphasis on reasoning, analysis, and systematic problem-solving. In conclusion, dealing with mathematics can cause anxiety in students, with various factors playing a role. Math anxiety can be triggered by several factors, such as nervousness in learning activities, difficulty participating,

and ability to do mathematics (Nurjanah & Alyani, 2021). High math anxiety is evident in students who appear nervous during presentations or when asked to speak in front of the class. They may need encouragement to explain their test results. Moderate math anxiety can also cause students to rush through presentations. Math teachers should take into account the psychological aspect of math anxiety because it can affect a person's math skills (Santoso, 2021). By boosting students' self-confidence, they can understand and solve math problems and overcome negative stereotypes about math, which can reduce their fear of the subject (Fauziah & Pujiastuti, 2020).

### **Students' Mathematical Communication Ability in Solving AKM-Type Questions Based on the Level of Mathematical Anxiety**

The study found that all students had equivalent levels of mathematical communication skills, with 3 students each scoring at the medium and high levels in both written and oral communication. This is a positive result because no students were found to have low skills in either area. Students demonstrated their skills by comprehending and writing information from questions, formulating questions, and finding solutions to given problems. These results were reported by Rizqi et al. in 2016.

When conducting research, it's important to use indicators of mathematical communication ability to develop questions. Each indicator requires at least two questions and enough time to accurately assess a student's mathematical communication abilities (Mariyam et al., 2016). Students who can fulfill all four indicators with precision and accuracy exhibit high mathematical communication ability, such as those in S4, S5, and S6. On the other hand, students in S1, S2, and S3 show moderate mathematical communication ability with some deficiencies in the four indicators. This means that they still need to meet all indicators accurately, whether it's understanding the questions or filling in answers, to improve their mathematical communication skills.

However, this study showed that students could solve AKM-type questions. Out of the 6 students, only one needed to improve their understanding of the questions' purpose and intent. This supports the findings of Anggraini and Setianingsih's research (2022), which suggests that students find AKM-type questions easier to comprehend due to their everyday life context. The students' correct answers demonstrate their achievement of the questions' objectives, despite room for improvement in meeting the mathematical communication indicators.

According to research conducted by Sulastri and Sofyan in 2022, students face difficulties when working on problems due to several factors such as a lack of understanding of the material, forgetting formulas, not comprehending the problem-solving process, and needing to be more meticulous in understanding the questions. One student, S3, faced some of these challenges because they did not pay close attention to the question and as a result, they did not achieve the intended objectives of the question. This is consistent with the findings of Wijaya and Adirakasiwi's (2022) research, which showed that students often struggle with answering questions because they do not read them thoroughly and become confused when working on them, leading to incorrect answers. This, in turn, causes students to encounter problems while attempting to solve problems.

According to Sulastri and Sofyan (2022), some students struggle with oral mathematical communication due to shyness, quietness, or lack of confidence in expressing their ideas. This was observed during presentations of S2 question results where some students spoke unclearly and covered their faces with answer sheets. Teachers can motivate and guide students to develop a better understanding of mathematical concepts, leading to enjoyable learning experiences. Darto et al. (2022) suggest that creating a pleasant learning process can help overcome the difficulties and obstacles that students face while learning mathematics.

In 2022, Adellia conducted research that showed that there is a strong negative correlation between math anxiety and students' mathematical communication skills. The level of communication ability was assessed using three test questions based on established indicators of mathematical communication. The results indicated that when math anxiety is high, mathematical communication skills tend to be low. Conversely, when math anxiety is low, mathematical communication skills tend to be high. However, unlike Adellia's study, another research found that there were differences in the mathematical communication skills of two subjects who experienced moderate levels of math anxiety. Subject S3 had medium communication skills, while subject S4 had high communication skills. In the test, S3 only met the requirements for perfect communication in one out of three questions, whereas S4 met them in two out of three questions. This difference highlights how two individuals with the same level of anxiety may have different levels of mathematical communication skills.

## **CONCLUSION**

The students were evaluated on their mathematical communication skills in both written and verbal form. Based on their level of math anxiety, it was found that all students had good mathematical communication skills with no students having low skills. However, three students had moderate skills in both areas, with two students having high math anxiety and one student having moderate math anxiety. The students with moderate mathematical communication abilities have some areas to improve, such as solving questions even though they have the correct answers. On the other hand, three students had high skills in both areas, with one student having moderate math anxiety and two having low math anxiety. Students with high mathematical communication skills were able to perfectly fulfill the mathematical communication indicators both in writing and verbally.

The results of the study were somewhat different from previous research. It was discovered that two students who experienced moderate math anxiety had varying abilities in written and verbal mathematical communication, with one having a medium level and the other having a high level. Further research can be conducted to improve this study and enhance students' mathematical communication skills in both written and oral forms.

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