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Meta Synthesis: Analysis of Mathematical Anxiety On Student's Mathematical Communication Skills

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ARTICLE INFO	ABSTRACT
	The purpose of this research is to describe the effect of mathematics anxiety on students' mathematical communication skills. The research method used in this study is meta-synthesis, which is a qualitative systematic review that analyzes articles relevant to the research title. The steps taken are to formulate the research problem, followed by searching for research that has been done that is relevant to the same title, then analyzing the research results in depth. The data collection technique used is non-test by reviewing research that has similar problems to obtain results and conclusions. This study surveyed several national articles. Analysis of the articles resulted in the conclusion that mathematical anxiety has a negative impact on students' mathematical communication skills. Students who have high mathematical anxiety have low mathematical communication skills. While students with low mathematical anxiety have a high level of mathematical communication skills.

INTRODUCTION

Mathematics is a subject studied by students from elementary school to high school and even college. This indicates that mathematics in its application is very much needed in everyday life so that it has a very important role, especially in the field of education. In improving the quality of mathematics education, of course, the government has tried to do various things such as holding seminars, training for teachers, creating subject teacher groups or Subject Teacher Deliberations. Evaluating the curriculum, choosing the learning model used, and so on (Cahya et al., 2024).

In mathematics learning, students are often seen to be less active in participating in

learning, students prefer to play with their deskmates rather than listen to the teacher explaining in front of the class (Putra & Sibarani, 2015). He also explained that students' courage to ask the teacher is very low, if students are given questions by the teacher, no student wants to answer the teacher's question if their name is not mentioned. In addition, it was found that students' mathematics learning outcomes are still very low. Putra & Sibarani explained that the low average student scores each year are due to the lack of knowledge about mathematical communication, so students are less interested in learning (Putra & Sibarani, 2015).

Mathematical communication skills are students' ability to use mathematics as a communication tool (mathematical language), and students' ability to communicate the mathematics learned as the content of the message that must be conveyed (Muslimahayati, 2019). According to Umar, students' mathematical communication skills are how students communicate their ideas in answering contextual problems given by the teacher, how students actively participate in discussions, and how to communicate problems given by the teacher (Umar, 2012). In addition, Sapto, Suyitno, & Susilo stated that mathematical communication skills are students' ability to convey opinions through events that occur in the classroom (Sapto et al., 2015).

Mathematical communication skills in mathematics learning are basic skills that must be possessed by students and teachers during learning, teaching, and evaluating mathematics because through mathematical communication students have the ability to apply and express understanding of mathematical concepts (Yuliani et al., 2020). Lestari & Mokhammad stated that mathematical communication skills are the ability to convey mathematical ideas/ideas, both verbally and in writing and the ability to understand and accept other people's mathematical ideas/ideas carefully, analytically, critically, and evaluatively to sharpen understanding (Hidayati & Armiati, 2022). Askin explains that the role of communication in mathematics learning is: (1) mathematical communication can be exploited in various perspectives, helping to sharpen students' thinking and sharpen students' abilities in seeing various mathematical relationships; (2) communication is a tool to measure the growth of understanding and reflect students' mathematical understanding; (3) through communication students can organize and consolidate their mathematical thinking; (4) communication between students in mathematics learning is very important for constructing mathematical knowledge, developing problem solving and improving reasoning, fostering self-confidence, and improving social skills; (5) "Writing and Talking" can be a very meaningful (powerful)

tool to form an inclusive mathematical community (Darkasyi et al., 2014).

Trisnani explained that there are two types of mathematical communication skills, namely written mathematical communication and oral mathematical communication (Trisnani, 2020). Oral communication (speaking) is a complex activity that includes a series of interactive skills, including reading, listening, discussing, explaining, and sharing information. This process allows individuals to express thoughts, ideas, and understanding directly and dynamically. Written communication (writing) presents a deeper dimension of ability, namely students' skills in using vocabulary, notation, and mathematical structures. This ability is not just about pouring out ideas, but also integrating various aspects such as reasoning, connections, and problem-solving. Through written communication, students can translate mathematical ideas into real-world phenomena, using various media representation including graphs, tables, algebraic equations, or everyday language in written form. Thus, mathematical communication, both oral and written, becomes a fundamental instrument in constructing, communicating, and developing comprehensive mathematical understanding.

Lestari and Yudhanegara also explained mathematical communication skills, according to them mathematical communication skills are the ability to convey mathematical ideas, both verbally and in writing and the ability to understand and accept other people's mathematical ideas carefully, analytically, critically, and evaluatively to sharpen understanding (Lestari & Yudhanegara, 2018). Lestari & Yudhanegara also explained that there are several indicators of mathematical communication skills including: (1) Connecting real objects, pictures, and diagrams to mathematical ideas. (2) Explain mathematical ideas, situations, and relationships orally or in writing, using real objects, pictures, graphs, and algebra. (3) Expressing everyday events in mathematical language. (4) Listening, discussing and writing about mathematics. (5) Read with understanding a written mathematical presentation. (6) Formulate mathematical questions that are relevant to the problem situation. (7) Making conjectures, constructing arguments, formulating definitions and generalizations (Lestari & Yudhanegara, 2018)

Based on the literature review conducted by (Sunaryo et al., 2024) related indicators in mathematical communication, several indicators were obtained as follows: 1) able to write (written text), which is explaining ideas or solutions to a problem or picture using their own language; 2) able to draw (drawing), which is explaining ideas or solutions to mathematical problems in the form of pictures; 3) able to do mathematical expressions (mathematical expression), which is stating problems or everyday events in the language of mathematical

models; 4) able to identify what is known, asked and explain how to find the answer; 5) the ability to draw conclusions from a mathematical problem.

In various studies, mathematical communication skills have been widely discussed, but the level of students' communication skills is still an aspect that must be studied because in practice students still find it difficult to communicate material about mathematics. Research results conducted by Li, Cho, Cosso and Maeda which researched mathematical anxiety stated that students are less likely to experience mathematics anxiety when they perceive themselves as being good at mathematics and interested in learning mathematics (Li et al., 2021). This indicated that there is a self-confidence factor that influences math anxiety which also affect their mathematical communication skills. But on the other hand, research conducted by Septian, Inayah and Afifah concluded that there is no influence between self-efficacy and mathematical anxiety on students' mathematical abilities (Septian et al., 2024). It is assumed that there are other factors that influence students' mathematical communication skills. In the implementation of mathematics learning, students often feel anxious during learning. Researchers assume that this is a factor of self-anxiety. In the study of mathematics, this is often referred to as mathematical anxiety.

Mathematical anxiety *is* a psychological phenomenon that is common among students and college students, where they feel stressed or afraid when facing mathematical tasks. This condition can affect mathematical communication skills, namely the ability to express mathematical ideas and concepts clearly and structured, both verbally and in writing. Mathematical communication is very important in the process of learning mathematics, because it helps students understand mathematical concepts better and explain their thoughts to others (Pantaleon et al., 2023). According to other expert, Mathematical anxiety is commonly defined as a feeling of tension, apprehension, or fear that interferes with math performance (Ashcraft, 2002).

The level of *mathematics anxiety* has a significant effect on students' mathematics learning achievement. The effect shown is a negative effect where when students' mathematics learning achievement increases, the level of students' *mathematics anxiety* decreases. Likewise, if students' mathematics learning achievement decreases, the level of students' *mathematics anxiety* will increase (Wuisan et al., 2024). Students' communication skills are inversely proportional to the mathematical anxiety possessed by students. Therefore, students' mathematical communication skills and mathematical learning achievement are influenced by students' mathematical anxiety levels.

In addition, math anxiety is also known to have a negative impact on students' mathematical communication skills. For example, students with high levels of math anxiety often have difficulty communicating mathematical ideas systematically and logically. One of the research results shows that students who experience high math anxiety tend to be less structured in conveying their mathematical ideas, compared to students who have low math anxiety. This can hinder the understanding of mathematical concepts and cause difficulties in solving problems that require logical reasoning (Putri et al., 2023). This is also in line with research conducted by Nurhasanah which states that there is a deep relationship between students' mathematical communication skills and mathematical anxiety. She also continued that there is an important role in controlling mathematical anxiety and the use of mathematical modeling in achieving mathematics learning goals, especially in mathematical communication skills (Nurhasanah et al., 2021).

There are several factors that influence the emergence of math anxiety, both from within the student and the environment. Internal factors such as lack of self-confidence in math abilities and negative thoughts about math are the main causes of this anxiety. On the other hand, external factors include pressure from family, friends, and a less supportive academic environment. The combination of these factors not only lowers students' achievement in math at school but also lowers students' motivation to communicate or discuss math in the classroom (Prahmana et al., 2019). Therefore, researchers are interested in conducting a literature research study on math anxiety towards students' mathematical communication skills.

RESEARCH METHODS

The method used in this study is meta-synthesis. Meta-synthesis can be defined as a qualitative systematic review method. Lewin explains that meta-synthesis has two approaches: aggregation meta-synthesis and meta-ethnography (Cahya et al., 2024). In this study, the approach used is meta-aggregation which summarizes various research findings that have been validated previously. Relevant research articles on this topic are searched, evaluated, and summarized. In the meta-aggregation approach, the research results include several research findings that are in line with relevant themes (Siswanto, 2010).

The primary thing to do is to select a planned subject. At that point the subject is depicted into certain subjects, proceeded by searching for articles that are important to the required subject and comparing them at that point summarizing the comes about of one

article with another. The results of the synthesis in this study include a collection of diverse research findings that are categorized based on relevant themes. The research conducted by the researcher aims to determine how mathematics anxiety affects students' mathematical communication skills. Research data were obtained by searching for scientific journals on Google Scholar using the keywords "Mathematics Anxiety", "Mathematical Communication", and qualitative from 2015 to 2024. Journals related to the research title were then analyzed by looking for essential things, namely mathematical communication skills, correlations between mathematical anxiety and mathematical communication skills.

This study produces a qualitative analysis that is described according to the important components in meta-synthesis. According to Francis and Baldesari the steps for meta-synthesis are as follows (Cahya et al., 2024):

1. Formulating research questions (formulating objective equations), determining research questions involves understanding the description of how mathematics anxiety affects mathematical communication skills.

2. Developing a protocol (conducting systematic literature research) looking for articles related to mathematics anxiety, mathematical communication and qualitative from 2015-2024

3. Screening and selection of appropriate research articles. The articles obtained were selected by considering the content of the articles using qualitative methods, including mathematical anxiety and mathematical communication skills.

4. Analyze and synthesize qualitative findings, analyze and synthesize previously selected articles.

5. Carrying out quality control. Ensuring that the articles produced meet the requirements to be considered as articles using qualitative meta synthesis methods.

6. Summarize and draw conclusions from the results of the article discussion.

RESULTS AND DISCUSSION

Analysis of several selected articles will be explained individually according to the components to be analyzed in each article. The main components to be analyzed in each article incorporate investigation of goals, strategies utilized, and what comes about. Article information is handled based on meta-synthesis steps. The taking after is information from a few articles that have been analyzed.

Table 1. Details of the Articles Math-Anxiety Analyzed

No	Article title	Writer	Year	Journal/proceedings
1	Mathematical Communication Ability from The Perspective of Math Anxiety in 10th Grade Student	Rizki Ahid Nurhasanah, St. Budi Waluya, Iqbal Kharisudin	2021	Unnes Journal of Mathematics Education Research
2	Hubungan Kecemasan Matematis dan Komunikasi Matematis Peserta Didik Kelas X MIPA SMAN 1 Rumbio Jaya	Isra Hidayati, Armiati	2022	Jurnal Cendekia: Jurnal Pendidikan Matematika
3	The Effect of Self-Confidence and Mathematics Anxiety on Mathematical Communication Ability of Class IX Students of Madrasah Tsanawiyah	Yuniarti, Sripatmi, Syahrul Azmi, Muhammad Turmuzi	2023	Jurnal Teknologi Pendidikan: Jurnal Penelitian dan Pengembangan Pembelajaran
4	Female Student Mathematical Communication Ability in the Proving Process: a Review Based on Math Anxiety	Kristianus Viktor Pantaleon, Dwi Juniati, Agung Lukito	2023	Bolema, Rio Claro (SP), v. 37, n. 77
5	Pengaruh Kecemasan Matematika Dan Kemandirian Belajar Terhadap Kemampuan Komunikasi Matematis Siswa Kelas VIII SMP Negeri 5 Praya Tahun Ajaran 2023/2024	Ria Arianti, Nurul Hikmah, Ni Made Intan Kertiyani, Syahrul Azmi	2024	Pendas: Jurnal Ilmiah Pendidikan Dasar
6	Mathematical communication ability viewed from mathematical anxiety in Team Assisted Individualization using Edmodo	Dhea Amalia Nur Karomah Dwidayanti	2020	Unnes Journal of Mathematics Education Research

The first article is "Mathematical Communication Ability from The Perspective of Math Anxiety in 10th Grade Student" (Nurhasanah et al., 2021). The data analysis process begins by describing the indicators of mathematical communication to be analyzed, namely: (1) the ability to write mathematical situations and mathematical problems including symbols, pictures, graphs, or mathematical models; (2) the ability to write mathematical problem solving; (3) the ability to draw conclusions from the mathematical problems. Continued by analyzing the indicators of mathematical anxiety according to Cooke's opinion. The final data analysis includes the results of the mathematical communication ability test and the data from the mathematical anxiety questionnaire. The results of the mathematical communication ability test reviewed from mathematical anxiety are described in the following table:

Table 2. Data on the Results of the Mathematical Communication Ability Test in terms of Mathematical Anxiety

Mathematical Anxiety	Mathematical Communication Skills		
	High	Medium	Low
High	1	1	4
Medium	6	17	3
Low	4	0	0

Students with high math anxiety with high math communication skills who master writing questions into mathematical modeling, solving math problems, and solving. There are also students with high math anxiety with math communication skills who master writing questions into mathematical modeling and solving math problems but are less proficient in solving. In addition, it was found that students with high math anxiety with low math communication skills were quite good at writing questions into mathematical modeling but were less proficient in solving problems and solving them. The results of the study also showed that there were students with moderate math anxiety with high math communication skills who mastered writing questions into mathematical modeling, solving math problems, and solving. In addition, there were students with moderate math anxiety with math communication skills who mastered writing questions into mathematical modeling, were quite good at solving math problems and were less proficient in solving. It was also found that students with moderate math anxiety with low math communication skills mastered writing questions into mathematical modeling but were less proficient in solving problems and concluding solutions. Based on the results of the study, it was also found that all students with low math anxiety had high math communication skills who were able to master writing questions into mathematical modeling, solving math problems, and concluding solutions.

The second article is entitled "The Relationship between Mathematical Anxiety and Mathematical Communication of Class X MIPA Students of SMAN 1 Rumbio Jaya" (Hidayati & Armiati, 2022). The data analysis process begins with the preparation of indicators of mathematical communication and mathematical anxiety, then analyzing the results of students' mathematical communication tests and the results of students' mathematical anxiety questionnaires. In this study, the relationship between the two variables was tested by test correlation based on the results of the mathematical communication ability test and mathematical anxiety. The findings in this study indicate that there is a significant negative relationship between mathematical anxiety and mathematical communication abilities of class X MIPA students of SMAN 1 Rumbio Jaya. This means that the higher the level of mathematical anxiety of students, the lower the students' mathematical

communication abilities, and vice versa, the lower the students' mathematical anxiety, the higher the students' mathematical communication abilities.

The third article is entitled "The Effect of Self-Confidence and Mathematics Anxiety on Mathematical Communication Ability of Class IX Students of Madrasah Tsanawiyah" (Yuniarti et al., 2023). This study uses the ex post facto research method, and the data analyzed are mathematical communication ability test data and mathematical anxiety questionnaire results. The findings of the study indicate that there is a negative and significant effect between mathematical anxiety on the mathematical communication ability of class IX students of MTsN 1 Mataram in the 2023/2024 academic year. This means that the higher the student's mathematical anxiety, the lower their mathematical communication ability. Conversely, the lower the student's mathematical anxiety, the higher their mathematical communication ability. The magnitude of the effect of mathematical anxiety on students' mathematical communication ability is 25.6%.

The fourth article is entitled "Female Student Mathematical Communication Ability in the Proving Process: A Review Based on Math Anxiety" (Pantaleon et al., 2023). This qualitative research begins with the determination of the research subjects. The research subjects were fifth semester students of the Mathematics Education Study Program, St. Paul Catholic University of Indonesia, Ruteng. The selected subjects were asked to sign a consent form to participate in this study. The subjects were assigned to work on answer sheets to support their written mathematical communication competencies. The researchers recorded every part of the subject's oral presentations and made important notes. The results were transcribed into written form and used as a guideline in the interview. Furthermore, the researchers also recorded the subjects' ideas written on the board during their oral presentations. To ensure the reliability of the data, the researchers tested the credibility of the data using time triangulation techniques. The findings showed that subjects with high levels of math anxiety were less systematic than subjects with low levels of math anxiety, even though their ideas were correct. However, subjects tend to be more careful in expressing their ideas. While subjects with low levels of math anxiety were not careful or careful in conveying their thoughts, they often made unintentional technical errors. However, subjects with low levels of math anxiety were more systematic in conveying ideas. However, both subjects are generally incomplete in expressing their ideas in written mathematical communication.

The fifth article is entitled "The Influence of Mathematics Anxiety and Learning

Independence on the Mathematical Communication Skills of Class V III S Students of MP Negeri 5 Praya in the 2023/2024 Academic Year" (Arianti et al., 2024). The research conducted used an *ex-post facto research type*. In this study, data was taken using a mathematics anxiety questionnaire and a mathematical communication ability test. Based on the method used in the study, the results of the mathematical anxiety data and the mathematical communication ability test data were analyzed using descriptive and inferential statistical analysis. The results of the study showed that there was a significant influence of mathematics anxiety on the mathematical communication skills of class VIII students of SMPN 5 Praya in the 2023/2024 academic year. The magnitude of the influence of mathematics anxiety on students' mathematical communication skills was 18.5%. This was obtained based on the mathematical anxiety questionnaire data and the mathematical communication test data of students from a selected sample of 45 students which were analyzed using regression analysis. One of the results of the study concluded that mathematics anxiety has a negative relationship with students' mathematical communication, which means that the higher the anxiety students' mathematics, the lower their mathematical communication skills, and conversely, the lower students' mathematical anxiety, the higher their mathematical communication skills.

The sixth article is entitled "Mathematical Communication Ability Reviewed from Mathematical Anxiety in Team Assisted Individualization Learning Using Edmodo" uses a mixed method with a sequential explanation approach (Amalia & Dwidayati, 2020). The results of the analysis of students' mathematical communication abilities based on the category of mathematical anxiety show significant variations. Students with low mathematical anxiety can complete all indicators of mathematical communication abilities. They can write down what is known and asked according to the problem, write mathematical symbols correctly, make relevant pictures, write answers according to the purpose of the problem, write reasons for answering questions, and make written conclusions in their own language. Students with moderate mathematical anxiety can complete five indicators of mathematical communication abilities. They can write down what is known and asked, write mathematical symbols correctly, make relevant pictures, write answers according to the purpose, and make written conclusions in their own language. However, they tend not to be able to write down the reasons for answering questions. Meanwhile, students with high mathematical anxiety are only able to complete four indicators of mathematical communication abilities. They can write down what is known and asked, write mathematical symbols correctly, make relevant

pictures, and make written conclusions in their own language. However, they are unable to write answers according to the purpose of the problem and write the reasons for answering the questions.

Based on the findings of the six articles, several similarities and differences can be concluded. The main topic discussed in the study is mathematical communication skills reviewed from the level of mathematical anxiety. The results of these studies show that mathematical anxiety affects mathematical communication skills. The six articles analyzed consisted of three articles discussing the influence of mathematical anxiety on mathematical communication skills qualitatively. The conclusion of the three articles shows that mathematical anxiety has a significant influence on students' mathematical communication skills. The other three articles are quantitative studies that produce the same conclusion, namely that mathematical anxiety has a negative effect on students' mathematical communication skills. We can consider this as a reinforcement of the three qualitative studies described above. The sixth article shows the learning model used, namely the Team Assisted Individualization learning model using Edmodo. This is an interesting study considering that there is media used as a differentiator from other studies. The fourth article analyzed also provides concentration on female students which is a unique feature of the research written. In several articles there are indicators of mathematical communication skills that are not analyzed due to the needs of research conducted by previous researchers. Therefore, the impact of mathematical anxiety on mathematical communication skills can be regarding as picture below.
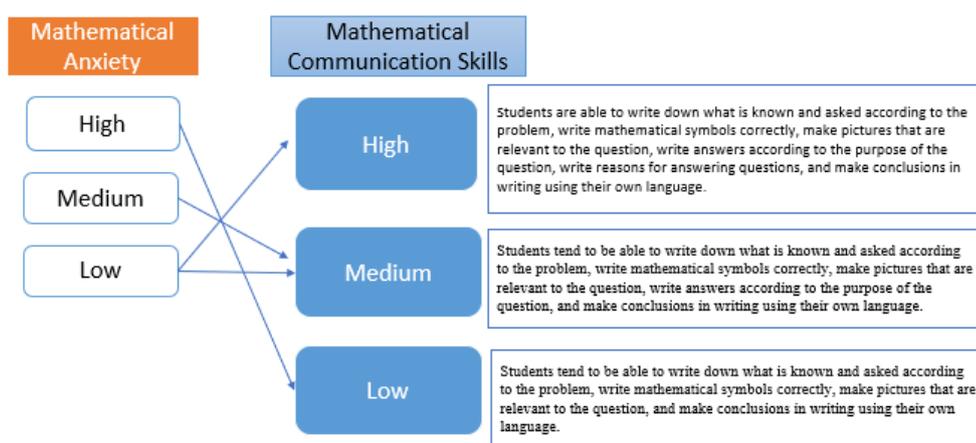

Figure 1. Relationship between mathematical anxiety and students' mathematical communication skills.

CONCLUSSION AND SUGGESTIONS

Based on the explanation given regarding mathematical anxiety in several articles that have been analyzed descriptively, the conclusion that can be drawn is that mathematical anxiety has a negative impact on students' mathematical communication skills. Students with low mathematical anxiety show optimal abilities in expressing mathematical communication skills. They are consistently able to describe what is known and asked according to the problem, use mathematical symbols accurately, create visual illustrations that are in line with the context of the problem, design answers that are right on target, describe mathematical reasons, and formulate conclusions in their systematic language. In contrast to students with low anxiety, students with moderate mathematical anxiety display mathematical communication skills in five main indicators. They successfully write down the information that is known and asked well, write mathematical symbols correctly, create relevant images, produce answers according to objectives, and draw conclusions using their language. However, this group shows weaknesses in explaining the mathematical reasons behind their answers. Meanwhile, students with high mathematical anxiety are only able to complete four indicators of mathematical communication. They can recognize and write down problems, use mathematical symbols correctly, create appropriate visual representations, and formulate conclusions. However, they have difficulty in writing answers that are appropriate to the objectives and stating the mathematical reasons behind solving the problem.

This study recommends that future researchers increase the number of articles analyzed to obtain more objective and maximum results. The greater the number of articles analyzed, the greater the possibility of new findings. For next researchers who are interested in re-examining variables of mathematical anxiety and mathematical communication, they can add several variables related to both.

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