Middle School Students' Mathematics Learning Difficulties in Function Material: A Systematic Literature Review

Aqidatul Izzah[1], Didi Suryadi[2*)], Jarnawi Afgani Dahlan[3], Mirza Aulia[4]
[1,2,3,4]Universitas Pendidikan Indonesia
*) didisuryadi@upi.edu

Abstract
This study aims to explore how the difficulties of high school students in learning mathematics, especially in functional materials. The data obtained in this study were 7 out of 22 articles and theses after going through a series of PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) stages with the Systematic Literature Review (SLR) approach. The articles and theses obtained came from Google Schoolar with the help of the Publish or Perish application. Based on the studies that have been analyzed, the results are obtained that students' mathematical difficulties, especially in function, are divided into three major parts, namely difficulties in the learning process, difficulties in working on problems, and internal and external difficulties. On the other hand, there is also an anticipation to reduce the occurrence of mathematical difficulties in students, including creating a supportive learning environment from the way of teaching and educating teachers, student readiness in learning, and comfortable school environments.
Keywords: students' mathematical difficulties, high school, Systematic Literature Review.

Introduction

Mathematics is one of the subjects that plays an important role in the formation of logical, analytical, and creative thinking skills. As a basic science, mathematics supports the mastery of various other fields of science, such as science, technology, and economics. Every aspect of human society makes use of the usefulness of mathematics. According to (Tijotob et al., 2023) the role of mathematics is very important, for example in vocational sectors such as the furniture industry, clothing industry, and culinary arts. In addition, sectors such as banking, music, shops, and other businesses require a strong understanding of mathematical knowledge. In terms of infrastructure development, mathematics plays a role as the backbone, helping the construction of roads, buildings, and enabling mechanical and electrical engineering (Tijotob et al., 2023). Thus, in everyday life the application of mathematical principles is inevitable. Mathematics is also known as a universal language, many linguistic and cultural elements can be effective in learning and teaching mathematics (Öztop, 2023). Therefore, it is important to pay attention to opportunities for students from different cultural backgrounds to learn mathematics. In this situation, for students from different cultures to learn better mathematics and become more successful in mathematics, then it is necessary to take steps to improve the educational practices of these students.

However, it is different in the field of education. Often learning mathematics becomes a big challenge for students. Many students consider mathematics to be a difficult subject, so the learning outcomes in this subject are often unsatisfactory. According to (Aprilia & Fitriana, 2022), students think that mathematics is difficult and complicated because it is always related to numbers, formulas and calculations, so that not a few students are lazy to study it except because of the demands of the material (Aprilia & Fitriana, 2022). This difficulty in learning mathematics includes several aspects, such as understanding basic concepts, operational skills, and applying mathematics in real-life situations (Fitriani & Kadarisma, 2022). Meanwhile, in the educational curriculum in Indonesia, mathematics is one of the mandatory subjects that must be mastered by students at all levels of education.

One of the mathematical materials contained in the education curriculum is functional material which is found at the high school level. As stated in the curriculum, this function material is one of the mandatory materials that needs to be mastered by students. Function material is one of the important topics in mathematics learning. Functions have abstract characteristics, involve relationships between two variables, and require logical thinking and visualization skills. Therefore, the concept of function is the basis for understanding various branches of mathematics such as algebra, trigonometry, calculus, and applied mathematics (Abdullah, 2010). However, many students have difficulty understanding the concepts of functions, such as the relationship between domains and ranges, mapping, and graph interpretation (Tall, 2013). Externally, teaching methods that are less varied and the lack of use of visual aids often make it difficult for students to visualize abstract functional concepts (Dubinsky & McDonald, 2001). Functional material involves various forms of representation, such as tables, graphs, and equations. Many students have difficulty connecting these representations, for example, translating functional equations to graphs or vice versa (Dubinsky & McDonald, 2001). According to Harel & Showder (2007), the absence of a contextual approach to functional learning makes it difficult for students to relate these concepts to real-world situations, so they feel less motivated to learn them (Harel & Sowder, 2007). In addition, in the operational aspect, students often face obstacles in solving problems involving value substitution, searching for domains and ranges, and analyzing functional properties such as confinement or sustainability (Harel & Sowder, 2007).

Various studies on students' learning difficulties and the level of understanding of the concept of student function have been explored, but the research varies in the focus, level of student education, and theoretical perspectives used. Some of these studies will be discussed in the results and discussion section. However, there has been no research that explores students' learning difficulties, especially in functional materials with the Systematic Literature Review (SLR) method. Therefore, the researcher is interested in studying the Systematic Literature Review (SLR) on students' mathematics learning difficulties. The material studied in this study is functional material. The level of education studied in this study is at the secondary school level, meaning junior and senior high school.

Method

This study uses a qualitative method with the Systematic Literature Review (SLR) approach. This approach has long been a means to summarize and present the conclusion of a knowledge, both current and historical derived from a collection of literature. SLRs often make use of published literature; Generally, published articles that are cited in a literature review and have gone through a blind peer review process (a characteristic of most scientific articles) (Aromataris & Pearson, 2014). The literature included in SLR research can include research that presents data, as well as conceptual or theoretical literature that focuses on a concept (Aromataris & Pearson, 2014). The stages carried out in this study adopt from Aromataris & Pearson (2014), namely Preferred Reporting Items for Systematic Reviews and Meta-Analysis or (PRISMA). These stages provide a checklist for researchers in the review on how to report a systematic review. Ultimately, the quality of the systematic review, and the recommendations drawn from it, depends on the extent to which the methods are followed to minimize the risk of errors.

The approach adopted consists of three steps, namely planning, screening, and conducting the automated content analysis (Mohamudally-Boolaky & Padachi, 2024).

1. Planning

   The database selected in this study is Google Schoolar based on its reputation for publishing scientific articles or quality research in the field of mathematics education. Google Schoolar ensures access to extensive and relevant scientific research in the field of mathematics education. Especially in this study, it includes scientific publications related to the difficulties of learning mathematics for high school students on functional materials. A total of 22 scientific studies were obtained from the

database on December 16, 2024. The following is a search term used to obtain scientific research: "Students' Learning Difficulties on Functional Materials".

2. Screening

   This screening is based on the inclusion and exclusion criteria shown in Table 1.

Table 1. Inclusion and Exclusion Criteria for Screening

Criterion	Inclusion	Exlusion
Database indexing	Google Schoolar	Other database
Literature type	Proceedings, Journal Articles, and Thesis (accessible)	Inaccessible
Type of research	Research Studies	Other type of research
Language	Language	Other language
Year of publication	All years	No exclusion
Focus of study	Difficulties in learning mathematics for high school students on functional material	Learning difficulties for students other than secondary school and other than mathematical function materials

3. Automated Content Analysis

   Based on screening on inclusion and exclusion criteria, a total of 7 scientific studies were obtained. There are some scientific studies that are not accessible and do not include the field of mathematics. Research that discusses how difficult it is for students to learn mathematics at the high school level. It only includes research in the field of functional material mathematics. It will be presented in Table 2.

Results and Discussion

The following is a scientific research obtained from a literature review carried out, there are 7 scientific studies in Table 2.

Table 2. Difficulties in Learning Mathematics for High School Students on Function Material

Writer	Year	Type of Reseach	Research Results
A. Mutahharah, Dewi, Nurfadhilah, Nurjannah	2022	Journal Article	There are two types of learning difficulties for students at the limit of the algebraic function of indefinite and infinite forms, namely difficulties in understanding concepts, such as difficulties in applying formulas and difficulties in solving problems, such as difficulties in applying formulas and difficulties in determining the steps to solve problems.
Dewi Anggreni, Zulfiqar Busrah,	2022	Journal Article	The difficulties experienced by students are difficulty understanding problems, difficulty in using concepts and

Gusniwati			principles, and difficulty in doing computational aspects.
Pinkan Pramesti, Ferry Ferdianto	2019	Journal Article	Students' difficulties in solving problems of composition functions and inverse functions are of the 3 types of difficulties experienced by students, the most common difficulties experienced by students are difficulties in understanding concepts by 86.7%, followed by difficulties in skills by 73.3% and difficulties in problem solving by 60%.
Euis Nopi Yulianti, Noviana Dini Rahmawati, FX Didik Purwosetiyono	2021	Journal Article	Students' difficulties include: 1) Students who have high motivation, tend to experience a little difficulty and this can be seen from the results of working on questions 1A and 1B where the students' answers are correct, only in question 1B students are not correct in giving conclusions at the end of the answer; 2) Students who have moderate motivation, tend to experience difficulties and it can be seen from the learning results that student 1A's answers do not provide conclusions and student 1B does not understand concepts and apply principles; 3) Students who have low motivation tend to have difficulties and may experience difficulties judging from the answers of students 1A and 1B who lack understanding of concepts, apply principles and difficulties in solving verbal problems.
Arif Subhan	2018	Thesis	(1) Difficulty in understanding mathematical language is classified as moderate with a percentage of 41.4%; (2) The difficulty in transferring knowledge is very high with a percentage of 64%; and (3) The difficulty in calculating was relatively high with a percentage of 53%.
Ajeng Aeka Putri	2020	Thesis	The difficulties experienced by students of grade VIII-F MTs Sunan Kalijogo Kranding Mojo Kediri in relation and function materials are (a) difficulties in understanding concepts, these difficulties are in the low category; (b) difficulties in applying principles, this difficulty is in the high category; (c) difficulty solving verbal problems (story problems), this difficulty is in the medium category.
Rendi Kurniawan Pratama	2023	Thesis	Students experience the ability to solve story problems at the stage of understanding problems, developing a solution plan and implementing a solution plan due to the lack of practice working on math problems in the form of stories.

Research by Mutahharah, et al. (2022) discusses the diagnosis of students' learning difficulties in the algebra function limit material in class XI MIPA 2 UPT SMA Negeri 1 Sinjai which obtained research results, namely there are two types of learning difficulties, namely difficulty in applying formulas and difficulty in solving problems, when studying algebraic function limit material in indefinite and infinite forms. Problem-solving, such as difficulty identifying steps to solve a problem. As for overcoming learning difficulties in the infinite algebra function limit material, namely increasing the enthusiasm for learning, referring to youtube and other reference materials, discussing with friends who master the material and practicing more. For teachers to pay attention to the learning difficulties experienced by students so that they can overcome them first before thinking that students are not able to process the material given by the teacher.

Research by Anggreni, et al. (2022) discusses the diagnosis of difficulties in learning mathematics of relationship and function materials in grade VIII MTs students. The research produced the types of difficulties of students in learning mathematics, relationship and function materials, as well as the factors that cause the difficulties that exist in students. The type of difficulty experienced by students is difficulty understanding the questions, this is shown by students making mistakes in understanding the questions and the lack of accuracy of students in reading the questions, as well as translating the questions given. Translation errors are errors that change information into mathematical expressions or give errors in giving meaning to a mathematical expression. Meanwhile, the difficulty in using concepts and principles is shown by students not taking steps systematically and incorrectly in doing calculations. The difficulty in doing the computational aspect is shown by the correct steps but not being thorough in calculating. The factors that cause students to have difficulties in learning mathematics, especially in the material of Relations and Functions, include the factors of the student's own personality, namely the factor of students' lack of interest in learning mathematics, because they consider that mathematics is very difficult to understand and full of calculations. As well as the lack of prerequisite knowledge possessed by students. Students' lack of interest in learning mathematics also greatly affects students in accepting mathematics subject matter in class. One of them is that they will not understand the material or questions given if they are not focused or feel bored in learning.

Research by Pramesti and Ferdianto (2019) which discusses the analysis of students' difficulties in learning mathematics in the material of the function of composition

and inverse function of class X of SMA Negeri 1 Rajagaluh. There are 3 types of difficulties experienced by students, the most common difficulties experienced by students are difficulties in understanding concepts at 86.7%, followed by difficulties in skills at 73.3% and difficulty at problem solving at 60%. Thus, teachers should always provide innovation and the right strategy in each learning so that students' difficulties in solving problems can be minimized.

Research by Yulianti, et al. (2021) discusses the analysis of students' difficulties in working on mathematical problems in the material of composition function and inverse function reviewed from learning motivation. This study results that there are differences in students' learning difficulties based on their level of learning motivation. Students with high learning motivation tend to have little difficulty, students with medium and low learning motivation tend to have difficulties. As for minimizing learning difficulties, (1) teachers are expected to emphasize more on understanding everyday language into mathematics so that students are able to convert the information in the questions into mathematical form appropriately; (2) teachers are expected to provide a better understanding of the use of formulas used in solving problems; (3) teachers are expected to pay more attention to students who have a low level of motivation with high difficulty so that they can keep up with students who have medium motivation and high motivation with low difficulty; (4) Teachers are expected to evaluate students who have difficulties in solving math problems reviewed from learning motivation.

Research by Subhan (2018) discusses the analysis of students' learning difficulties in solving problems in functional material in grade XI of the Department of Administration-1 SMK Negeri 7 Medan. This study obtained the results that, (1) The difficulty in understanding mathematical language was classified as moderate with a percentage of 41.4%; (2) The difficulty in transferring knowledge is very high with a percentage of 64%; and (3) The difficulty in calculating was relatively high with a percentage of 53%. The difficulties of students in the high-ability category include three aspects, namely: 1) Understanding the language, 2) Transferring knowledge, 3) Difficulty in counting. The difficulty of students in understanding the language is that students do not understand what is asked in the question. In transferring knowledge, students are wrong in determining formulas and wrong in determining symbols. The difficulty of students in calculating is that students are wrong in determining the results of substitution multiplication operations. The difficulty of understanding the language in the medium

category is that students are unable to determine what is asked in the question. In the difficulty of transferring knowledge, students are wrong in determining the steps in solving problems. In the difficulty of counting, students are wrong in calculating the operation of quadratic equations. Difficulty understanding the language in the low category is that students are wrong in determining what is asked and determined, then students are confused to see the questions before working on them. In the difficulty of transferring knowledge, students have difficulty in multiplying symbols, in the difficulty of calculation, students misdetermine the result in multiplication operations.

Research by Putri (2020) discusses the diagnosis of mathematics learning difficulties of students in grades VIII-F on the material of relationships and functions at MTs Sunan Kalijogo Kranding Mojo Kediri for the 2019/2020 school year which results that students experience learning difficulties including, (a) difficulties in understanding concepts, this difficulty is in the low category; (b) difficulties in applying principles, this difficulty is in the high category; (c) difficulty solving verbal problems (story problems), this difficulty is in the medium category. The factors that cause students to experience learning difficulties are (a) internal factors, including 1) students lack interest in mathematics lessons; 2) lack of students' knowledge of the meaning of mathematical forms; 3) students are less able to understand the meaning of the problem, especially the story problem that uses the concept of relationship and function; 4) students are less able to apply the principles of relationship and function; 5) students do not understand the concept of relationships and functions such as improper placement of symbols; 6) students are less able to build, construct or develop their own knowledge of relationships and functions. (b) external factors, including 1) lack of adequate school facilities and support students' interest and motivation to learn; 2) lack of motivation from students' parents; 3) the influence of social partners. (3) solutions or alternative solutions that can be done are (a) scaffolding techniques, (b) peer tutors, (c) remedial learning.

Research by Pratama (2023) discusses the analysis of students' learning difficulties in solving story problems in the functional relationship material of grade VIII students of SMP Negeri 8 Bengkulu City. It can be seen that some of the difficulties felt by students when solving story problems include difficulty understanding problems as much as 16%, this is due to difficulties in understanding the meaning of the problem and students have not mastered the basic concepts of mathematics and the lack of students doing exercises working on story problems. Difficulty in compiling a completion plan as many as 41% of

students this is because students do not master the material of functional relations and prepare a completion plan, most students also tend to forget the material that has been taught before. Difficulties in implementing the solution plan as many as 52% of students are because students are still confused in understanding the problem, have not been able to make a model of the given story problem and have not been able to solve the problem. The re-examination of 52% of students was due to the fact that students had made many mistakes in the early stages so that students were unable to reach the re-examination stage. The factor that causes this difficulty that is faced by students with low, medium and high abilities is because students rarely practice doing story problems so they have to read the questions repeatedly and eventually run out of time.

To overcome the existing difficulties, there needs to be direct attention from teachers. For example, in Zhang's research (2022), it is stated that several points that teachers must pay attention to include (Zhang, 2022): 1) Changing teaching strategies. Teachers can change their teaching strategies according to the situation. It is good to adopt more heuristic teaching, such as: abstract concrete, mathematical history, mathematical stories and so on, to stimulate students' interest in mathematics learning and gradually cultivate students' interest in mathematical abstract ability and problem-solving ability, as well as solve problems. 2) Improve the dual evaluation system. The difficulty of the exam paper should be moderate, given the situation of students of different levels. It can reduce the degree of difficulty in learning mathematics for students. We must destroy the evaluation method that relies only on grades and awards. Instead, teachers should change the evaluation method that only takes the exam paper as the final grade. We must pay attention to process evaluation and assess students objectively through self-evaluation, joint evaluation and evaluation groups. 3) Pay attention to the psychological state of students. Counselors and teachers should pay attention to the daily learning status of students and help students in this regard clarify their goals through offering courses such as career planning. At the same time, we must pay attention to students with serious mathematical difficulties. It is necessary to open psychological counseling channels and analyze the causes of mathematical difficulties according to individual situations.

Another way that can reduce difficulties is by understanding how the brain learns and connecting it to the field of education to produce a concept known as brain-based learning (Olaoluwa, 2024). It is defined as any teaching, technique, or strategy that utilizes information about the human brain to organize, how lessons are constructed, and facilitated

with an emphasis on how the brain learns naturally. Therefore, the researchers are of the view that if brain-based learning strategies are adopted to teach Mathematics, students' abilities can be better improved. In terms of contextual thinking, creative reasoning, logical thinking, sequential learning, intuitive knowledge and insightful learning that is resistant to forgetfulness and this will help better cognitive and affective learning outcomes in the field of mathematics. Brain-based learning, sometimes called "Brain-Compatible Learning" is an educational approach based on what recent research in the field of neuroscience suggests about how our brains naturally learn well (Olaoluwa, 2024). It involves specific strategies for learning that are designed based on how human attention, memory, motivation, and conceptual knowledge acquisition work. Brain-based learning and teaching can optimize learning holistically. With new technologies that allow scientists to observe brain function as it happens, we gain insights into how the brain learns, assimilates, thinks, and remembers. From these findings, an educational approach called brain-based learning has emerged that has developed.

Based on the theories that have been mentioned, that students who are positive about mathematics because they get quality teaching practices such as involving students, student-centered learning, supporting student learning by giving time, help and guarantees about mathematical skills (Boyd et al., 2014). This shows the power that teachers have in supporting children to learn mathematics. Choosing a teacher-centered approach, especially in the early years of math learning, proved to be much more effective than a child-centered approach where children "find" knowledge by interacting with concrete material. Children's learning has been proven to be optimized by having an effective educator who works side by side and supports children's learning.

Conclusion and Suggestion

Based on the results of the research, the difficulties in learning mathematics of high school students in function material consist of three major parts, namely, difficulties in the learning process which include understanding or misconceptions of concepts in theory about functions, difficulties in understanding problems about functions including mistakes in understanding the meaning of the problem, errors in the use of formulas. Finally, there are difficulties caused by internal and external factors, such as the lack of interest in learning mathematics among students (internal) and the lack of school facilities that support the learning process (external). These things can be overcome or minimized in

various ways. Of course, the main thing is to create a learning environment that supports the way of teaching and educating teachers, the readiness of students in learning, and the state of a comfortable school environment.

References

Abdullah, S. A. S. (2010). Comprehending the concept of functions. *Procedia - Social and Behavioral Sciences*, *8*, 281–287. https://doi.org/10.1016/j.sbspro.2010.12.038

Aprilia, A., & Fitriana, D. N. (2022). Students' Initial Mindset Towards Difficult and Scary Mathematics Learning. *PEDIR: Journal Elementary Education*, *1*(2), 28–40. https://doi.org/10.4324/9780203457306-42

Aromataris, E., & Pearson, A. (2014). The Systematic Review. *AJN, American Journal of Nursing*, *114*(3), 53–58. https://doi.org/10.1097/01.naj.0000444496.24228.2c

Boyd, W., Foster, A., Smith, J., & Boyd, W. E. (2014). Feeling Good about Teaching Mathematics: Addressing Anxiety amongst Pre-Service Teachers. *Creative Education*, *05*(04), 207–217. https://doi.org/10.4236/ce.2014.54030

Dubinsky, E., & McDonald, M. A. (2001). *APOS: A Constructivist Theory of Learning in Undergraduate Mathematics Education Research*. Springer.

Fitriani, F. N., & Kadarisma, G. (2022). Analysis of Students' Difficulties in Solving Social Arithmetic Problems in Grade VII Students. *Journal of Innovative Mathematics Learning*, *5*(1), 187–194. https://doi.org/10.22460/jpmi.v5i1.187-194

Harel, G., & Sowder, L. (2007). Toward Comprehensive Perspectives on the Learning and Teaching of Proof. In *Mathematics Teaching* (Vol. 6179, Issue 619, pp. 1–60).

Mohamudally-Boolaky, A., & Padachi, K. (2024). Leveraging Technology for Math Education: A Systematic Literature Review. *Creative Education*, *15*(08), 1692–1704. https://doi.org/10.4236/ce.2024.158102

Olaoluwa, S. A. (2024). Application of Brain-Based Learning Strategy for Students' Optimal Learning Outcomes in Mathematics. *Creative Education*, 2037–2052. https://doi.org/10.4236/ce.2024.1510126

Öztop, F. (2023). Research Trends on Mathematics Education of Multicultural Students in Turkey. *Dynamics of Science*, *23*(2), 277–290.

Tall, D. (2013). How Humans Learn to Think Mathematically: Exploring the Three Worlds of Mathematics. In *Cambridge University Press* (Issue February). https://doi.org/10.1017/CBO9781139565202

Tijotob, P. M., Mifetu, R. K., & Adu - Gyamfi, R. (2023). Effects of multiple representations-based instruction on junior high school students' achievement in linear equations in one variable. *Journal of Advanced Sciences and Mathematics Education*, *3*(1), 27–39 https://doi.org/10.58524/jasme.v3i1.199

Zhang, X. (2022). Current Situation and Strategy of Mathematics Anxiety among Mathematics Majors. *Creative Education*, *13*(03), 929–940. https://doi.org/10.4236/ce.2022.133061