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Factors Causing Misconceptions Among Students in Mathematics Subjects

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Abstract
Misconceptions in mathematics learning are a common problem among students and can affect the understanding of important basic concepts. This research aims to identify the factors that cause misconceptions in mathematics subjects. This research uses the literature study method. This research was carried out by collecting data from various literature sources. The collected data is then analyzed using descriptive analysis methods to understand and describe the information in depth. Some of the main factors identified include a low understanding of basic concepts, the use of less effective teaching methods, limited learning media, and minimal interaction and feedback from teachers. Additionally, difficulties in understanding the language of mathematics and errors in interpreting mathematical symbols or terms also become significant causes. Another factor that plays a role is anxiety towards mathematics, low learning motivation, and the lack of contextual learning application. The results of this study provide insights for educators to design more effective learning strategies to reduce misconceptions and improve mathematical understanding among students.
Keywords: *misconceptions, mathematics, students, learning*

Abstrak
Miskonsepsi dalam pembelajaran matematika merupakan masalah yang sering terjadi di kalangan peserta didik dan dapat mempengaruhi pemahaman konsep-konsep dasar yang penting. Penelitian ini bertujuan untuk mengidentifikasi faktor-faktor yang menyebabkan terjadinya miskonsepsi pada mata pelajaran matematika. Penelitian ini menggunakan metode studi literatur. Penelitian ini dilaksanakan dengan mengumpulkan data dari berbagai sumber literatur. Data yang terkumpul kemudian dianalisis menggunakan metode analisis deskriptif untuk memahami dan menggambarkan informasi secara mendalam. Beberapa faktor utama yang ditemukan antara lain rendahnya pemahaman konsep dasar, penggunaan metode pembelajaran yang kurang efektif, keterbatasan media pembelajaran, serta minimnya interaksi dan umpan balik dari guru. Selain itu, kesulitan dalam memahami bahasa matematika dan kesalahan interpretasi simbol atau istilah matematis juga menjadi penyebab signifikan. Faktor lain yang turut berperan adalah kecemasan terhadap matematika, rendahnya motivasi belajar, serta kurangnya penerapan pembelajaran kontekstual. Hasil penelitian ini memberikan wawasan bagi para pendidik untuk merancang strategi pembelajaran yang lebih efektif dalam mengurangi miskonsepsi dan meningkatkan pemahaman matematika di kalangan peserta didik.
Kata kunci: *miskonsepsi, matematika, peserta didik, pembelajaran*

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INTRODUCTION

Misconception or misunderstanding of concepts in mathematics learning is a problem that is commonly encountered at various levels of education. These incorrect concepts often hinder students' learning processes and can progress to erroneous understandings when students move on to more complex material (Smith, diSessa, & Roschelle, 1994). According to Nesher (1987), misconceptions are mistaken understandings that students have about a concept or principle, often formed from incorrect interpretations or inappropriate generalizations. In mathematics learning, misconceptions can be an obstacle in developing critical thinking and problem solving skills, considering that mathematics is a discipline that relies heavily on interconnections between concepts and gradual understanding (Kilpatrick, Swafford, & Findell, 2001).

International data shows a high number of mathematics misconceptions among students. The PISA (Program for International Student Assessment) program, for example, notes that the majority of students in various countries have difficulty understanding fundamental mathematical concepts, such as probability, fractions, and data representation (OECD, 2018). Likewise, the 2019 TIMSS (Trends in International Mathematics and Science Study) results showed that more than 30% of students showed misunderstandings in basic mathematical concepts that they should have mastered by a certain age (Mullis, Martin, Foy, & Hooper, 2016). This phenomenon is not limited to one particular country or education system, but occurs globally, including in countries with high levels of mathematical literacy. These facts indicate that misconceptions in mathematics are an educational problem that needs to be resolved so that students can achieve a better understanding in this field.

Previous research shows that misconceptions in mathematics can be caused by various factors, including ineffective teaching methods, lack of supportive learning media, and students' limitations in understanding abstract mathematical language (Bell, 1993). In addition, students often experience difficulties when they try to relate abstract mathematical concepts to their everyday experiences, so they tend to develop inappropriate understandings which ultimately progress to misconceptions (Nesher, 1987). According to Hiebert and Grouws (2007), learning that focuses too much on procedures without understanding basic concepts can be one of the main factors in creating misconceptions. Students may be able to remember procedures for solving math problems, but they often do not understand the reasoning behind those procedures or the situations in which they apply. As a result, when they are faced with a variety of different problems, they are unable to apply appropriate procedures, which then leads to misconceptions.

Factors influencing misconceptions also include a lack of student-centered and contextual teaching approaches. In a study conducted by Batanero, Godino, and Roa (2004), it was found that students taught with a more interactive and problem-based approach showed better understanding of mathematical concepts and experienced fewer misconceptions compared to those who learned through a more traditional approach. teacher-centered. This study shows that an active teaching approach can help students understand concepts better and reduce the risk of misconceptions. In addition, mathematics learning supported by media or visual aids can improve students' understanding of abstract concepts, especially in geometry and statistics material, where visual representation is very important (Clements & Sarama, 2009).

On the other hand, misconceptions can also come from students' internal sources, such as limited problem-solving abilities and wrong perceptions regarding the properties of mathematics itself (Lamon, 2001). When students feel that mathematics is a collection of rules and procedures that must be memorized, they tend to develop an inflexible understanding, which ultimately leads to misconceptions when they encounter new problems. Lamon (2001) notes that students who have misconceptions about

fractions, for example, tend to view fractions as two unrelated numbers, and these misconceptions often persist until they study more advanced material. According to the results of this research, misconceptions that are not addressed early on can develop into erroneous understandings in the broader field of mathematics.

The importance of this research is also supported by the results of studies which show that students who have misconceptions in mathematics tend to have low self-confidence in their own mathematical abilities. This especially happens to students who repeatedly experience failure in understanding certain concepts, so that they feel frustrated and lose motivation to learn mathematics (Lester, Garofalo, & Kroll, 1989). In research conducted by Hiebert and Grouws (2007), it was found that students who had difficulty understanding basic mathematical concepts were more likely to avoid challenges and have negative attitudes towards mathematics. This attitude can hinder further learning and reduce students' academic performance.

Based on the problems and research findings above, the aim of this research is to analyze the main factors that cause misconceptions in mathematics learning among students. It is hoped that this research can contribute to the development of more effective and contextual teaching strategies to help students achieve correct understanding. By identifying the factors that cause misconceptions, it is hoped that educators can design teaching approaches that are more appropriate to students' needs, so as to minimize conceptual misunderstandings and improve the quality of mathematics learning in schools. For example, a teaching approach that is more student-centered and uses visual learning media might be a solution in dealing with misconceptions about complex concepts.

Overall, this research seeks to provide new insights that are useful for educators, researchers and policy makers in overcoming the problem of mathematics misconceptions. By understanding the fundamental causes of misconceptions, it is hoped that more targeted learning strategies can be developed, so that students can achieve better understanding and feel more confident in learning mathematics. In addition, it is hoped that this research can become a basis for further research on effective evaluation and intervention strategies to overcome misconceptions among students.

METHOD

This research uses a literature study or literature review approach, which aims to identify, analyze, study, evaluate and interpret relevant research results regarding the causes of misconceptions in the field of mathematics (Putra & Afrilia, 2020). This approach was chosen because it allows researchers to identify, assess, and synthesize related findings from various sources to understand the factors that influence student misconceptions (Triandini et al., 2019).

The data in this research comes from journal articles, books, conference proceedings, and research reports that are relevant to misconceptions in mathematics learning. The main data sources are 30 national and international journals published in the last 10 years to ensure that the data used is current and relevant. Article searches were carried out through scientific databases such as Google Scholar, ERIC, ProQuest, and ScienceDirect (Triandini et al., 2019).

The data collection technique in this literature study is done in a systematic way through the stages of identification and selection of sources as well as classification and coding. The data that has been collected is classified based on the categories of factors that cause misconceptions, such as cognitive factors, environmental factors, and teaching factors. Coding was done to group findings from each source to facilitate thematic analysis (Creswell, 2013). The data obtained was analyzed using content analysis techniques (*content analysis*) to identify the main themes emerging in the literature.

RESULTS AND DISCUSSION

Misconceptions in mathematics are a phenomenon that often occurs at various levels of education, from elementary school to higher education. Incorrect understanding of basic mathematical concepts can cause difficulties in learning advanced material, and the impact can be ongoing in the student's learning process. The factors that influence the emergence of these misconceptions are very diverse, ranging from cognitive, affective, to environmental and pedagogical aspects. Each of these factors contributes to forming inaccurate understanding, which ultimately hinders students' ability to understand and apply mathematical concepts correctly. Understanding the causes of misconceptions is an important step in developing more effective and appropriate educational strategies to help students achieve a deep and correct understanding of mathematics. Factors that cause mathematical misconceptions in students can be grouped into several main categories, including:

A. Cognitive Factors Causing Misconceptions in Mathematics

Cognitive factors play an important role in forming misconceptions among students in understanding mathematical concepts. Misconceptions often occur due to students' difficulties in understanding abstract concepts or building a correct understanding of basic mathematical concepts. According to Cognitive Load Theory, information processing in students' minds is limited to short-term memory capacity, which means that too much complex information can cause misconceptions (Sweller, 2010).

1. Working Memory Limitations

Working memory has an important role in information processing during mathematics learning, especially in terms of storing and manipulating information temporarily. However, limited working memory capacity can prevent students from managing information effectively, so they tend to forget important steps in understanding concepts. According to Lee and Cho (2017), students who have limited working memory have difficulty solving problems that require sequential steps, so they often experience misconceptions because the information they remember is not complete enough.

2. The Influence of Erroneous Thinking Schemes

Thinking schemas, or mental patterns formed based on previous experiences, greatly influence how students understand new concepts. When the thinking schemes that have been formed do not match the concepts being taught, students tend to rely on old schemes which could be wrong. For example, students may be accustomed to thinking that division always results in a smaller number, so they have difficulty understanding fractions. In a study by Tarmizi and Bayat (2018), it was found that students often adhere to wrong thinking patterns, which causes them to experience misconceptions in understanding more complex mathematical concepts.

3. Difficulty in Connecting Concepts

Students who experience misconceptions often have difficulty connecting related mathematical concepts. Mathematical understanding requires the ability to see connections between concepts, but when students are unable to see these connections, they tend to understand concepts separately and in a limited way. According to a study by Kotsopoulos and Lee (2020), students who are less able to connect concepts tend to understand mathematics in a fragmented way, so they do not have a coherent overall picture. This makes them vulnerable to misconceptions when facing problems that require them to relate various concepts.

4. Lack of Conceptual Understanding

Conceptual understanding is basic in learning mathematics, but students who lack this understanding tend to just memorize procedures without understanding the logic behind them. As a result, when faced with questions that are different from the ones they have memorized, they experience confusion and often use the wrong approach. Rittle-Johnson and Schneider (2015) revealed that students who focus more on memorizing procedures have a tendency to misapply concepts, especially in new situations or those that require in-depth understanding.

Conclusion

Cognitive factors, including limited working memory, the influence of erroneous thinking schemes, difficulty in connecting concepts, and lack of conceptual understanding, are some of the main causes of misconceptions in mathematics. Paying attention to and understanding these factors can help in designing more effective learning strategies to prevent and overcome misconceptions.

B. Affective Factors Causing Misconceptions in Mathematics

Affective factors relate to students' emotional and motivational aspects that can influence their understanding of mathematical concepts. Misconceptions in mathematics are often caused by negative affective conditions that make students experience difficulty in understanding or internalizing the concepts being taught (Hannula, 2006). These factors include math anxiety, low motivation to learn, and negative attitudes toward math.

1. Mathematics Anxiety

Mathematics anxiety is a feeling of excessive fear or anxiety about mathematics, which often prevents students from thinking clearly and processing information well. According to Ashcraft and Krause (2007), students who experience mathematics anxiety tend to have impaired working memory capacity, making it difficult for them to understand or remember mathematical concepts correctly. This often causes errors in the understanding process, which ultimately develop into misconceptions.

2. Low Motivation to Learn Mathematics

Low learning motivation also contributes to misconceptions in mathematics. Students who are less motivated to learn mathematics tend to have a passive attitude in class and make less effort to understand the material in depth. According to Wigfield and Eccles (2000), intrinsic motivation plays an important role in encouraging students' interest and persistence in learning. Without sufficient motivation, students tend not to carry out the exploration necessary to avoid wrong understanding or misconceptions.

3. Negative Attitudes towards Mathematics

Negative attitudes towards mathematics, such as the belief that mathematics is a difficult and uninteresting subject, can also cause misconceptions. This attitude can stem from unpleasant learning experiences or previous failures in understanding mathematical concepts. Furinghetti and Pehkonen (2002) stated that students with negative attitudes are more likely to experience misconceptions because they tend not to be serious about studying or checking their understanding of the mathematical concepts being studied.

4. Lack of Self-Confidence (*Self-Efficacy*) in Mathematics

Confidence or *self-efficacy* in mathematics plays a large role in a student's academic success. Students who have low self-confidence tend to doubt their ability to understand or do math problems. According to Bandura (1997), the low *self-efficacy* can cause students to avoid challenges or not try hard when they encounter difficulties, leading to wrong understanding or misconceptions.

Conclusion

Affective factors such as mathematics anxiety, low motivation, negative attitudes, and lack of self-confidence have a significant impact on students' misconceptions in mathematics. Understanding these factors allows teachers to create a more supportive learning environment and minimize the possibility of misconceptions.

C. Environmental Factors Cause Misconceptions in Mathematics

The environment has a significant influence on the way students understand and accept mathematical concepts. Environmental factors that influence mathematics learning include family environment, school, and peer influence. If these environmental factors are less supportive or actually lead students to wrong understandings, misconceptions in mathematics will be more likely to occur.

1. Family Environment

Family support, especially parental attitudes and involvement, can influence how students understand mathematics. Parents who feel anxious or have a negative attitude towards mathematics may unknowingly transmit these feelings to their children, which in turn causes the children to feel less confident or even afraid of math lessons. Based on a study by Maloney et al. (2015), parents' mathematics anxiety can be transmitted to children and affect children's mathematics achievement and understanding, potentially causing misconceptions.

2. School environment

Environmental factors that play a role in causing misconceptions in mathematics include the influence of the learning environment, such as the quality of the curriculum, the role of the teacher, and social expectations regarding mathematics subjects. Several studies show that curriculum structures that are irrelevant or less flexible often do not support students' understanding in relating mathematical concepts to real situations, which can cause students to feel that these concepts are abstract and difficult to understand (Frontiers, 2020). Apart from that, the role of teachers is very significant. Teachers who do not provide varied explanations or do not use effective learning aids tend to increase the opportunity for misconceptions among students. Teaching methods that prioritize memorization or procedural rather than conceptual approaches can also reinforce errors in understanding (International Journal of Academic Research, 2020).

3. Peer Influence

Social expectations and perceptions of mathematics as a "difficult" subject also provide psychological pressure for students. Students often feel inadequate or tend to avoid this subject due to the influence of negative views in their environment, such as from peers or family, who perceive mathematics as a difficult subject (Frontiers, 2020).

4. Education Policy

Educational policies, such as curriculum standards, national tests, and pressure to achieve certain results, can influence how mathematics is taught in schools. If education policies focus too much on exam results or do not provide space for in-depth understanding, students tend to learn by rote without fully understanding concepts. A study by Rohrer and Pashler (2010) highlights that educational policies that encourage rapid and results-oriented learning tend to reinforce misconceptions because students only study to pass exams without understanding the basics of mathematical concepts.

Conclusion

Family environment, school, peers, and educational policies can influence how students understand mathematics. Without adequate support, misconceptions in

mathematics are more likely to occur because students may not receive comprehensive and correct learning.

D. Pedagogical Factors Causing Misconceptions in Mathematics

Pedagogical factors or factors related to the way teachers teach contribute significantly to students' mathematics misconceptions. For example, teaching methods that emphasize more direct teaching and involve less conceptual understanding often cause students to memorize procedures without understanding the underlying concepts (Kapur, 2018). A study by Field (2020) also shows that teaching techniques that do not challenge students cognitively and only focus on solving problems mechanically can exacerbate their misconceptions. Teaching methods that only emphasize correct answers without utilizing error analysis are also one of the causes of students not having a deep understanding of concepts, so they are vulnerable to experiencing misconceptions in the future (Field, 2020).

In addition, several studies show that teachers who use less visual aids or concrete models in teaching mathematics tend to limit students' understanding. According to research results from Brown and Phelps (2017), the use of visual models helps students understand abstract concepts better. If the teacher does not provide it, students will more easily experience misconceptions, especially on abstract topics.

A recommended strategy for reducing misconceptions is to engage in “error analysis” techniques in which students are encouraged to identify and correct their own errors. This approach has been proven to significantly increase the retention of mathematical understanding in students, especially when used routinely (Field, 2020).

E. Material and Textbook Factors Cause Misconceptions in Mathematics

Teaching material and textbook factors can influence misconceptions in mathematics, especially when the material is not organized logically or contains an approach that is too formal and abstract. Textbook structures that place less emphasis on conceptual understanding and introduce new concepts too quickly can make it difficult for students to build a strong foundation of understanding. Several studies show that a material approach that is contextual and based on everyday reality can help reduce misconceptions by increasing student involvement in understanding abstract concepts (Susilawati, Suryadi, & Dahlan, 2017; Chow & Treagust, 2013).

CONCLUSION

Misconceptions in mathematics play an important role in forming misconceptions in students. Cognitive factors play an important role in understanding mathematical concepts. Limited working memory, influence of erroneous thinking schemes, difficulty in connecting concepts, lack of conceptual understanding, mathematics anxiety, motivation to learn mathematics, negative attitudes towards mathematics, and self-confidence (*self-efficacy*) in mathematics.

Job limitations include excessive feelings of fear or anxiety about mathematics, which often prevent students from thinking clearly and processing information correctly. Low learning motivation also contributes to misconceptions in mathematics. Negative attitudes towards mathematics, such as the belief that mathematics is a difficult and uninteresting subject, can cause misconceptions. Self-confidence in mathematics plays a large role in a student's academic success. Lack of self-confidence in mathematics plays a large role in a student's academic success. Self-confidence in mathematics plays a large role in a student's academic success.

The implications of this journal are curriculum development and educational policy. Curriculum adjustments by providing recommendations for a curriculum that is more adaptive to common misconceptions, for example by emphasizing basic mathematical concepts. Further highlighting the importance of teacher training in identifying and addressing misconceptions, including the use of diagnostic techniques and concept-based teaching strategies. It is hoped that other researchers can conduct further research that can explore more deeply the factors that cause misconceptions and interventions that can help overcome misconceptions in the long term.

REFERENCE

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review*, 14(2), 243-248.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Batanero, C., Godino, J. D., & Roa, R. (2004). Training teachers to teach probability. Journal of Statistics Education, 12(1), 1-9.

Bell, A. (1993). Principles for the design of teaching. Educational Studies in Mathematics, 24(1), 5-34.

Brown, L., & Phelps, G. (2017). Content knowledge for teaching mathematics. *Journal of Teacher Education*, 68(5), 437-451.

Chand, S., Chaudhary, K., Prasad, A., & Chand, V. (2021). Perceived causes of students' poor performance in Mathematics: A case study at BA and Tavua Secondary Schools. *Frontiers in Applied Mathematics and Statistics*, *7*. doi:10.3389/fams.2021.614408

Clements, D. H., & Sarama, J. (2009). Learning and teaching early math: The learning trajectories approach. Routledge.

Creswell, J. W. (2013). Qualitative Inquiry and Research Design: Choosing Among Five Approaches (3rd ed.). Thousand Oaks, CA: Sage.

di Martino, P., & Zan, R. (2010). "Me and maths": Towards a definition of attitude grounded on students' narratives. *Journal of Mathematics Teacher Education*, 13(1), 27-48. https://doi.org/10.1007/s10857-009-9134-z

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, 7(5), 324-326. https://doi.org/10.2307/748467

Field, J. (2020). Teaching and learning mathematics through error analysis. *Fields Mathematics Education Journal*, 18, 245-269.

Fumador, E. S., & Agyei, D. D. (2018). Students' Errors And Misconceptions In Algebra: Exploring The Impact Of Remedy Using Diagnostic Conflict And Conventional Teaching Approaches. Retrieved from https://www.researchgate.net/publication/309344387_Misconceptions_and_Learning_Algebra

Furinghetti, F., & Pehkonen, E. (2002). Rethinking Characterizations of Beliefs. In G. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A Hidden Variable in Mathematics Education?* (pp. 39-57). Dordrecht: Kluwer.

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). Educational Research: An Introduction (8th ed.). Boston: Pearson.

Hannula, M. S. (2006). Motivation in mathematics: Goals reflected in emotions. *Educational Studies in Mathematics*, 63(2), 165-178.

Hiebert, J., & Grouws, D. A. (2007). The effects of classroom mathematics teaching on students' learning. In F. K. Lester (Ed.), Second handbook of research on mathematics teaching and learning (pp. 371-404). Information Age Publishing.

Jamaludin, N. H., & Maat, S. M. (2020). A systematic literature review on students misconceptions in Mathematics. *International Journal of Academic Research in Business and Social Sciences*, *10*(6). doi:10.6007/ijarbss/v10-i6/7273

Jankvist, U. T., & Niss, M. (2018). Counteracting destructive student misconceptions of Mathematics. *Education Sciences*, *8*(2), 53. doi:10.3390/educsci8020053

Kapur, M. (2018). Productive failure in mathematical problem solving. *Journal of Educational Psychology*, 110(3), 368–390.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). Adding it up: Helping children learn mathematics. National Academy Press.

Kotsopoulos, D., & Lee, J.-E. (2020). Unpacking mathematical misconceptions: A focused look on how they shape students' understanding. *Journal of Mathematical Behavior*, 59, 1-12. https://doi.org/10.1016/j.jmathb.2020.100810

Lamon, S. J. (2001). Presenting and representing: From fractions to rational numbers. In A. A. Cuoco (Ed.), The roles of representation in school mathematics (pp. 146-165). NCTM.

Lee, J., & Cho, H. (2017). The influence of working memory on students' mathematical misconceptions. *Educational Psychology*, 37(5), 580-593. https://doi.org/10.1080/01443410.2017.1298092

Lester, F. K., Garofalo, J., & Kroll, D. L. (1989). Self-confidence, interest, beliefs, and metacognition: Key influences on problem-solving behavior. In D. B. McLeod & V. M. Adams (Eds.), Affect and mathematical problem solving (pp. 75-88). Springer.

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological Science*, 26(9), 1480-1488. https://doi.org/10.1177/0956797615592630

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological Science*, 26(9), 1480-1488. https://doi.org/10.1177/0956797615592630

Middleton, J. A., & Spanias, P. A. (1999). Motivation for achievement in mathematics: Findings, generalizations, and criticisms of the research. *Journal for Research in Mathematics Education*, 30(1), 65-88. https://doi.org/10.2307/749630

Mullis, I. V. S., Martin, M. O., Foy, P., & Hooper, M. (2016). TIMSS 2015 International Results in Mathematics. TIMSS & PIRLS International Study Center, Boston College.

Nesher, P. (1987). Towards an instructional theory: The role of student's misconceptions. For the Learning of Mathematics, 7(3), 33-39.

OECD. (2018). PISA 2018 Results: Combined Executive Summaries, Volume I, II, & III. OECD Publishing.

Rittle-Johnson, B., & Schneider, M. (2015). Developing conceptual and procedural knowledge in mathematics: An iterative process. In *Educational Psychologist*, 50(3), 109-120. https://doi.org/10.1080/00461520.2015.107541

Rohrer, D., & Pashler, H. (2010). Recent research on human learning challenges conventional instructional strategies. *Educational Researcher*, 39(5), 406-412. https://doi.org/10.3102/0013189X10374770

Smith, J. P., diSessa, A. A., & Roschelle, J. (1994). Misconceptions reconceived: A constructivist analysis of knowledge in transition. Journal of the Learning Sciences, 3(2), 115-163.

Susilawati, W., Suryadi, D., & Dahlan, J. A. (2017). The improvement of mathematical spatial visualization ability of student through cognitive conflict. *International Electronic Journal of Mathematics Education*, *12*(2), 155–166. doi:10.29333/iejme/607

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, 25(1), 68-81.