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MISCONCEPTIONS OF MATHEMATICS IN HIGHER EDUCATION UNIVERSITIES WHEN LEARNING WITH GOOGLE CLASSROOM BASED ON LEARNING STYLES AND GENDER DIFFERENCES

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Abstract

The purpose of this study is to comprehensively describe the results of the analysis of the ability to understand concepts and misconceptions in terms of differences in learning styles, as well as gender differences. The data to be collected in this study is in the form of primary data and secondary data. The primary data is obtained from primary sources and secondary data is obtained from secondary sources. The primary source in this study is informants, namely students, and the secondary source is documentation of student test scores as an illustration of student abilities. The instruments in this study are student learning style tests and auxiliary instruments in the form of misconception diagnostic tests. Learning style test in the form of a questionnaire. This instrument is used to uncover visual, auditorial, and kinesthetic learning style variables. Misconception diagnostic tests use the Certainty of Response Index (CRI). The results of the CRI analysis based on student answer criteria are: (a) 5.83% of student problem solving do not know the concept (lucky guess); (c) 22.30% of the student problem solvers did not know the concept; (b) 50.18% of student problem solving mastered the concept well; and (d) 21.69% of student problem solving occurred misconceptions.

Keywords – Misconceptions, Google classroom, Learning styles, Gender.

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1. Introduction

Technology has played a significant role in enhancing the contemporary education system across different levels of learning, including schools, colleges, and universities. Its utilization has not only improved the effectiveness of teaching and learning in classrooms by focusing on learners' needs and outcomes but has also encouraged teachers to employ it as a tool to connect traditional methods with the modern educational demands, fostering overall learner development (Gray & Lewis, 2021). An examination of its implementation across various levels and settings reveals the swift adoption of diverse information and communication technologies, serving as catalysts to augment the learning process (Delić-Zimić & Gadžo, 2018; Gupta & Fisher, 2012; Nwobi, Ngozi, Rufina & Ogbonnaya, 2016; Tonui, Kerich & Koross, 2017; Ahmadi, Keshavarzi & Foroutan, 2011). Nevertheless, establishing student-centered learning environments in classrooms through technology is achievable. Google Classroom has made significant inroads in the education sector and is recognized as a powerful tool with vast educational potential. Developed by Google, Google Classroom is a free web service designed for schools, facilitating the seamless creation, distribution, and grading of assignments in a paperless manner. Its core objective is to simplify the sharing of files between teachers and students (Gupta & Pathania, 2021).

In a study conducted by (Basher, 2017) examining the impact of Google Classroom on the teaching efficiency of pre-teachers, an experimental approach was employed. The research sample was divided into two groups: a controlled group taught through traditional methods and an experimental group utilizing Google Classroom. The findings revealed significant statistical disparities in the results between the experimental and control groups when Google Classroom was utilized. College students' teaching efficiency in planning, execution, and evaluation, as well as their academic achievements in computer-related subjects, demonstrated improvement compared to the traditional teaching methods.

Heggart and Yoo (2018) conducted a study assessing the effectiveness of Google Classroom in engaging final-year primary teacher education students and promoting their active participation and autonomy. The research also aimed to analyze the potential impact of the platform on future teaching methods at the tertiary level. The findings indicated that Google Classroom enhanced student involvement, learning outcomes, and overall classroom dynamics. However, concerns regarding the speed of learning and user experience were identified. This data served as the basis for developing a framework to evaluate various online platforms, focusing on four key concepts: pace, accessibility, collaboration, and student involvement/autonomy (Naeem-Ahmed & ur Rehman, 2021; Borova, Chekhratova, Marchuk, Pohorielova & Zakharova, 2021; Bergström & Wiklund-Engblom, 2022). These concepts were instrumental in assessing the utility of other online learning platforms and informing pedagogical practices. Learning math through Google Classroom can provide many benefits, but several math misconceptions often occur when using the platform: Learning math often requires direct interaction with a teacher or fellow students. Lack of direct communication can make it difficult for students to understand complex mathematical concepts. Mathematical concepts are often easier to understand through visual demonstrations, such as diagrams or pictures. In online environments, the use of visual tools is often limited, making it difficult for students to understand the material well (Bringula, Reguyal, Tan & Ulfa, 2021; Radmehr & Goodchild, 2022).

Misconceptions of Mathematics According to Learning Style consist of Visual Learners: Students who are visual learners tend to have difficulty in mathematics if there is no visual representation of mathematical concepts. They need diagrams, graphs, or illustrations to understand mathematical formulas and relationships. Auditory Learners: Students who are auditory learners understand information through hearing. They may experience difficulties if mathematics lessons are primarily delivered through written text without oral explanation or discussion. Kinesthetic Learners: Kinesthetic type students require physical experience and direct interaction with the material. They may have difficulty understanding abstract math concepts without concrete examples or hands-on activities (Fleming, 1992). While math misconceptions according to gender differ, studies show that some female students tend to feel less confident in their math abilities, which can hinder their motivation and performance in this subject. Boys and girls may deal with math errors in different ways. Some research suggests that women tend to internalize their mistakes and find it more difficult to recover, while men may find it easier to overcome their mistakes and move on. Social interactions in mathematics classes, especially the gender stereotypes that develop, can influence student performance. For example, girls may feel held back by the perception that mathematics is a subject for boys (Hyde, Fennema & Lamon, 2010; Pajares, 2004).

Research on mathematical misconceptions based on learning styles needs to be carried out because mathematical misconceptions based on learning styles allow teachers to design learning experiences that suit students' individual needs. Research has shown that many difficulties in learning math stem from students' failure to understand the underlying concepts, which form the basis for the procedures they are using. Identifying and addressing these misconceptions is essential for promoting access and attainment for all students (Schnepper & Mccoy, 2017). Understanding how misconceptions are related to one another can be useful for identifying broader patterns that affect students' long-term mathematical development (Rakes & Ronau, 2019). A personalized approach to learning can help students understand and overcome their mistakes more effectively. Research on learning style-based mathematical misconceptions helps teachers identify typical error patterns in students with certain types of learners. This allows the development of specific and effective interventions to help students overcome their errors and improve mathematical understanding. By understanding students' learning styles and overcoming their misconceptions, teachers can help increase students' motivation and confidence in learning mathematics. Students who feel understood and supported in their learning styles are more likely to be motivated to overcome their mistakes and achieve better academic progress (Alcaro, Carta & Panksepp, 2017; Felder & Silverman, 1988).

This research by Ecclestone, Hall, Coffield and Moseley (2004) and Kolb (1984) helps identify error patterns that are typical of certain types of learners. This allows teachers and education professionals to design specific and effective interventions to help students overcome their errors and improve mathematical understanding. Research into learning style-based mathematical errors helps develop teacher skills. By understanding how students of different types of learners deal with errors in understanding, teachers can design more effective and inclusive teaching strategies.

By understanding students' learning types, teachers can allocate time and resources more efficiently. Focusing on aspects of understanding that require more attention can increase learning efficiency (Pashler, McDaniel, Rohrer & Bjork, 2008). Study by Hattie and Timperley (2007) provides the basis for the development of innovative, evidence-based mathematics teaching methods. By understanding how students of different types understand mathematics, teachers can design more engaging and effective learning experiences. The importance of research on mathematics misconceptions is linked to learning styles, creating learning environments that support and motivate students with various types of learners, increasing their understanding of mathematics, and overall, improving the quality of mathematics education. Visual, auditory, and kinesthetic learning styles have a significant influence on the learning process (Syofyan & Siwi, 2018). The learning style is a way to easily take in, process, retain, and apply the knowledge. Each learner has a unique manner of learning. The visual, aural, and kinesthetic learning styles of students can be distinguished. Students who learn visually learn through what they see, those who learn auditorially learn through what they hear, and those who learn kinesthetically learn through movement and touch.

Meanwhile, research on mathematical misconceptions based on gender has significant relevance and interest in the field of mathematics education because it can identify typical error patterns. Research by Else-Quest, Hyde and Linn (2010) helped identify patterns of math errors that are common among male and female students. Knowing these differences allows teachers to design more targeted teaching strategies, helping students overcome their mistakes effectively. Understanding the differences in errors between male and female students helps identify aspects of mathematics that may contribute to a lack of self-confidence in female students. By overcoming these mistakes, female students can build their confidence in understanding and mastering mathematics (Gunderson, Ramirez, Levine & Beilock, 2012). Research by (Eccles, 1994) provides teachers and educators with insight into the differences in male and female students' mathematical understanding. With this knowledge, teachers can dig deeper into helping students overcome their mistakes, creating an inclusive and supportive classroom atmosphere.

From the description above, the objectives of this research are: (a). to identify the types of conceptual errors that are often experienced by students when they use Google Classroom as a mathematics learning platform. This identification helps in designing targeted interventions to improve student understanding. (b). analyze how students' learning styles influence mathematical conceptual errors. By understanding how students with different types of learners tend to make conceptual errors in mathematics, this research can provide insight into how instruction can be tailored to individual learning needs. (c). to explore whether there are differences in mathematical conceptual errors between male and female students. Identifying these differences can help in developing more inclusive and supportive teaching strategies for students of both genders. (d). By combining analysis of mathematical misconceptions, learning styles, gender differences, and the use of Google Classroom, this research is expected to provide in-depth and useful insights for educational practitioners in improving the quality of mathematics teaching and learning.

From the research objectives above, the following Research Questions (RQ) can be formulated:

- RQ (1): What is the learning style of students in learning with Google Classroom in elementary mathematics education courses?
- RQ (2): How is the ability to understand student concepts in learning with Google Classroom in elementary mathematics education courses when viewed from learning styles?
- RQ (3): How is the ability to understand student concepts in elementary mathematics education courses when viewed from gender and learning style?
- RQ (4): How are student misconceptions about learning with Google Classroom in elementary mathematics education courses when viewed from learning styles?
- RQ (5): What are the misconceptions of students in elementary mathematics education courses when viewed from gender and learning styles?

2. Methodology

2.1. Types of Research

This study falls under the category of qualitative descriptive research (Roberts, Dowell & Nie, 2019; Seixas, Smith & Mitton, 2018; Soroush, Andaieshgar, Vahdat & Khatony, 2021), which aims to characterize student misconceptions in relation to the learning preferences of the students (Feldman, Cho, Ong, Gulwani, Popovic & Andersen, 2018; Jankvist & Niss, 2018; Mishra, 2020; Parwati & Suharta, 2020). Because the researcher only conducted analysis that reached the level of description–that is, methodically analyzed and presented the facts–it is referred to as descriptive research. In this study, all data–oral and written–from human sources that have been observed, as well as other relevant materials that represent the situation as it is, are analyzed and succinctly presented to address research questions using a qualitative methodology.

Conducting qualitative descriptive research can be an effective way to investigate and comprehend the features and attributes of a phenomenon (Rahman, 2016). Nevertheless, employing this study design has certain drawbacks, such as: Although it leads to richer understanding, qualitative descriptive research limits generalizability by yielding a significant amount of detailed information about a smaller number of participants. The conclusions won't apply to different groups or situations. To ensure that the data obtained from qualitative research are accurate, careful planning and a lengthy process are necessary. It can take a few weeks or months to finish. Qualitative research relies less on outcomes and more on judgment and opinion. Qualitative data cannot be mathematically analyzed, and observations and conclusions might be influenced by one's own knowledge and experience. Since qualitative research relies more on subjective interpretation than on objective measurement, it is not a good method for examining causation.

2.2. Research Sample

The research sample consisted of 38 third-semester students of the Primary School Teacher Education Study Program, at Mataram University, Indonesia who were taking the Primary School Mathematics Education course. They consisted of 7 male students and 31 female students. They carried out online lectures via Google Classroom for 9 meetings including carrying out a mathematics misconception test.

2.3. Data Collection Technique

The subjects of this research were 38 students at the University of Mataram Primary School Teacher Education Study Program Indonesia. The data that will be collected in this research will be primary data and secondary data. Primary data is obtained from primary sources and secondary data is obtained from secondary sources. The primary source in this research is informants, namely students, and the secondary source is grade documentation. In accordance with the form of a qualitative research approach and the data sources that will be used, data collection techniques in this research use questionnaires, documentation methods, and test methods. In qualitative research, the most common methods of data collection are interviews, focus groups, observations, and document study (Gill, Stewart, Treasure & Chadwick, 2008; Busetto, Wick & Gumbinger, 2020).

The learning style test is in the form of a questionnaire. According to Newton (1984), a questionnaire is a data collection technique that is carried out by giving respondents a set of questions or written statements to answer. The questionnaire used in this research is a closed questionnaire, namely a questionnaire that is equipped with answers so that students just have to choose the answer. This instrument is used to reveal visual, auditory, and kinesthetic learning style variables. Instrument scoring is made using a Likert scale with four alternative answers. The answers to each instrument have a gradation from very positive to very negative in the form of words, as shown in Table 1.

The questionnaire given to students is divided into 3 parts, namely: visual learning style questionnaire, auditory learning style, and kinesthetic learning style. The misconception diagnostic test is in the form of a test with elementary mathematics education material. Every time a student solves a problem, the lecturer always asks to write down a measure of the student's level of confidence in the answer. This aims to diagnose the occurrence of misconceptions. The questionnaire of learning styles by students is carried out through google form. To create a Google Form for students to complete a learning style questionnaire, follow these steps: Open Google Forms by searching for "Google Forms" in your web browser and clicking on the first result. Click the "+" button to create a new form. Give your form a title, such as "Learning Style Questionnaire." Add questions to your form that assess different learning styles. You can use multiple-choice, checkbox, or dropdown questions. In Figure 1 here is the front page of the google form.

Positive Statements	Score	Negative Statements	Score
Strongly Agree (SA)	4	Strongly Disagree (SD)	1
Agree (A)	3	Disagree (D)	2
Disagree (D)	2	Agree (A)	3
Strongly Disagree (SD)	1	Strongly Agree (SA)	4

Table 1. Questionnaire Statement Answer Score

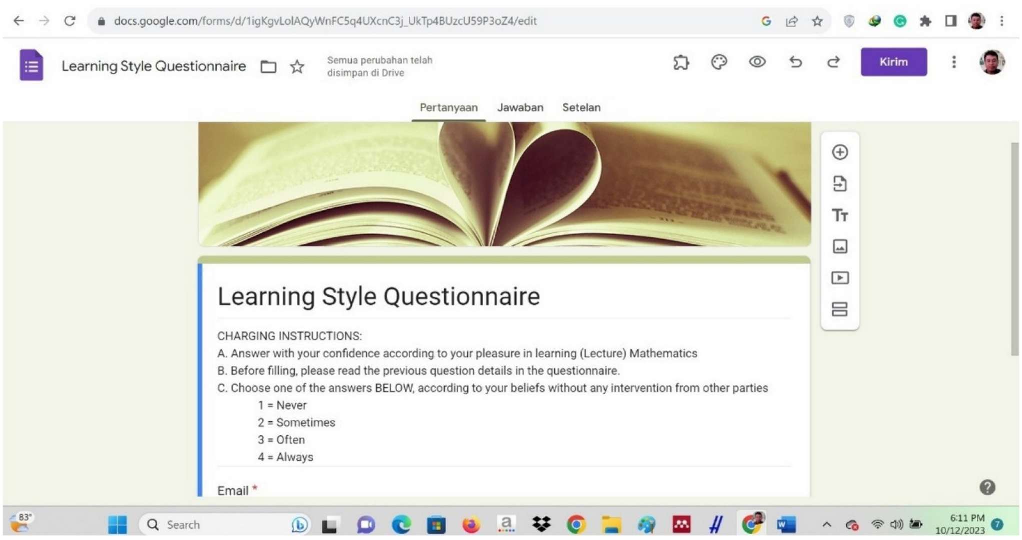

Figure 1. Google Form front page view for learning style questionnaire

2.4. Research Instrument

Twenty statement indicators make up the mathematics misperception instrument used in this study. that claim was categorized into indicators based on the study variables, and its reliability and validity were then examined. The Table 2 and Table 3 below displays the results of the validity and reliability tests:

No	Question Indicator	r Count	r Table	Note
1	Find the meaning behind the notation and the concept of numbers.	0.56	0.26	Valid
2	Execute the integer operation.	0.45	0.26	Valid
3	Complete the integer operations problems in the story.	0.48	0.26	Valid
4	Solve story problems related to Least Common Multiple and Greatest Common Factor	0.69	0.26	Valid
5	Identify the circle's area	0.33	0.26	Valid
6	Look at the characteristics of quadrilaterals.	0.56	0.26	Valid
7	Calculate a geometric shape's surface area.	0.67	0.26	Valid
8	determining a tube's volume	0.78	0.26	Valid
9	Solve whole-number word puzzles.	0.63	0.26	Valid
10	Apply your application knowledge to multiple-number and number factor issues.	0.57	0.26	Valid
11	Determine the outcomes of the addition and multiplication of prime numbers.	0.34	0.26	Valid
12	The block's perimeter should be known.	0.7	0.26	Valid
13	calculating comparable comparison outcomes	0.48	0.26	Valid
14	Calculate the triangle's surface area.	0.71	0.26	Valid
15	Determine a flat shape's perimeter.	0.53	0.26	Valid
16	understand how prime numbers work and composite numbers	0.37	0.26	Valid
17	Calculate the angles at which two lines intersect and are parallel.	0.74	0.26	Valid
18	Find the location where the circle and triangle intersect.	0.55	0.26	Valid
19	determining algebraic fractional operations	0.48	0.26	Valid
20	Find the place value in a sequence of numbers.	0.38	0.26	Valid

Table 2. Validity test results

Validity testing is a crucial step in research to determine how well the measurement tool genuinely captures the idea or variable under investigation (Boateng, Neilands, Frongillo, Melgar-Quiñonez & Young, 2018; Franke & Sarstedt, 2019; Knekta, Runyon & Eddy, 2019). The degree to which an instrument can be trusted to measure what it is intended to measure is known as its validity. At the 5% significant level, all computed r values are greater than r table 0.26, according to the validity test findings in Table 2. Therefore, it can be said that every statement item in the mathematics misconceptions instrument has been deemed legitimate and is appropriate for use in the following study phase.

Table 3 shows that the reliability test findings yielded a reliability coefficient value (Cronbach Alpha) of 0.735 for all indicators, which is greater than 0.6. This indicates that the research instrument is dependable. The produced questionnaire instrument can be employed at the next stage of the study based on the findings of validity and reliability tests.

Reliability Coefficient (Cronbach Alpha) is a statistical measure used to measure the extent to which the items or questions in an instrument are consistent or reliable (Bujang, Omar & Baharum, 2018; Sivaprasad, Tschosik, Kapre, Varma, Bressler, Kimel et al., 2018; Taber, 2018). The Cronbach Alpha value ranges between 0 and 1, and the closer it is to 1, the higher the reliability of the instrument. This value of 0.735 shows a high level of instrument reliability. With a value greater than 0.6, the instrument is considered reliable. In this case, the value of 0.735 indicates that the instrument has a level of consistency and is reliable in measuring the variables or concepts studied.

Indicator Statement Number	Item Variance	Total Item Variance	Total Variance	Reliability
1	3.143	106.61	376.19	0.735
2	4.2524			
3	3.3617			
4	4.5196			
5	6.3765			
6	0.6734			
7	4.7787			
8	3.6923			
9	5.9028			
10	4.1835			
11	2.2524			
12	6.766			
13	5.305			
14	7.9406			
15	2.5641			
16	5.1471			
17	6.9649			
18	7.8435			
19	6.6373			
20	14.305			

Table 3. Reliability test results with Cronbach Alpha

2.5. Data Analysis Techniques

This research is classified as qualitative descriptive research so that the data The existing ones are analyzed with qualitative data analysis techniques, namely the process of searching and systematically compile obtained data, field notes, and materials Other. Analysis of qualitative research data is carried out by organizing data, break it down into units, classify, organize into In the pattern, choose which ones are important and which ones will be studied so that you can a conclusion is made to convey to others. The data analysis technique used is narrative descriptive with using the Miles and Huberman model. Miles and Huberman (Rahman, 2016), suggest that activities in qualitative data analysis are carried out in a timely manner. interactive and takes place continuously until complete, so the data Saturated. A measure of data saturation is characterized by no more data or new information.

Qualitative data analysis in this study, namely: 1) data reduction is the stage of summarizing and focusing data from research analysis and eliminate unpatterned data, then the data is collected and selected in accordance with the purpose of the study; 2) Display data, data that has been reduced presented in the form of a short description so that it is easy to read and understand both in whole and in parts; and 3) conclusion drawing/ Verification, conclusions are drawn based on the results of the analysis of all data that has been obtained (Wong, 2008; St John & Johnson, 2000).

2.6. Research Procedure

Research procedure in this study are as follows.

- Researchers conduct preliminary ability tests. The initial ability test (quis) is conducted online to find out Initial ability of students regarding subject prerequisite materials Elementary Mathematics Education.
- Researchers (lecturers) hold lectures. Lectures through the Google Classroom application based on the results of the analysis of the initial ability of college students. Some material should be given with portions that more because it is considered very important, but there are still many

students who don't understand yet. This resulted in pre-Elementary Mathematics Education material taking quite a long time (3x meetings), total meetings in Lectures have 9 meetings.

- Researchers (lecturers) conduct quizzes and assignments. At some meetings, researchers give quizzes and assignments online. These tasks are done on folio paper and archived on Google Each student's classroom is a portfolio assessment.
- Researchers (lecturers) hold Midterm Exam. After the seventh meeting, lecturers held a Midterm Exam according to the faculty schedule. Students must add a level description certainty of the correctness of the answer to each question he solves.

2.7. Misconception Analysis

Hasan, Bagayoko and Kelley (1999) identified the occurrence of misconceptions, at once can differentiate between not knowing the concept, by developing an identification method known as CRI (Certainty of Response Index). CRI measures the respondent's level of confidence/certainty in answering each question (problem) given. A low CRI indicates a lack of confidence in the respondent's concept in answering a question. On the other hand, a high CRI reflects high confidence and certainty in the concept in respondents (Firmasari & Nopriana, 2020; Latif, Mursalin, Buhungo & Odja, 2021). CRI was developed with a six scale (0 – 5) in Table 4 the following.

The following are provisions for distinguishing between knowing the concept, misconceptions and not knowing the concept for individual respondents. As in Table 5, those who can be categorized as having misconceptions are students who answer incorrectly, however, the CRI score they choose is in the high category (above 2.5). These misconceptions can come from students themselves, from lecturers who convey wrong concepts, inappropriate teaching methods, and wrong textbooks. Some misconceptions come from the students themselves, one of which is influenced by the students' learning styles.

CRI	**Criteria**
0	(*Totally guessed answer*)
1	(*Almost guess*)
2	(*Not Sure*)
3	(*Sure*)
4	(*Almost certain*)
5	(*Certain*)

Table 4. CRI and its Criteria

Answer criteria	**Low CRI (CRI < 2.5)**	**High CRI (CRI > 2.5)**
Answer Correct	Correct answer but low CRI lucky guess	Correct answer and high CRI master the concept with Good
Wrong answer	Wrong answer and low CRI don't know the concept	Wrong answer but high CRI misconceptions

Table 5. CRI analysis based on answer criteria

A learning style test in the form of a questionnaire is a data collection technique that is carried out by giving a set of questions or written statements to respondents to answer. The questionnaire used in this research is a closed questionnaire, namely a questionnaire that is equipped with answers so that students just have to choose the answer. To collect data on learning preferences based on gender and learning styles, a learning style test in the form of a questionnaire can be used. This questionnaire should be designed to assess students' learning style preferences and provide a clear indication of their overall style preferences (Cohen, Oxford & Chi, 2006). This instrument is used to reveal visual, auditory, and kinesthetic learning style variables (Kamal, Karim, Kechik, Ni & Razak, 2021; Hussein-Ibrahim & Hussein, 2015).

The questionnaire given to students is divided into 3 parts, namely: visual learning style questionnaire, auditory learning style, and kinesthetic learning style. The diagnostic test for misconceptions is a test with material 1) Whole numbers, 2) Whole numbers, 3) Exponentiation and taking roots of whole numbers, 4) Multiples and factors of numbers, 5) Rational and irrational numbers, 6) Percents, comparisons and scales, 7) Build flat, and 8) Build. Every time a student solves a problem, the lecturer always asks to write down a measure of the student's level of confidence in the answer. This aims to diagnose the occurrence of misconceptions. Filling out diagnostic test for misconceptions answers is carried out by students by answering questions through google form as seen in Figure 2. Sample questions for diagnostic test for misconceptions as seen in Figure 3.

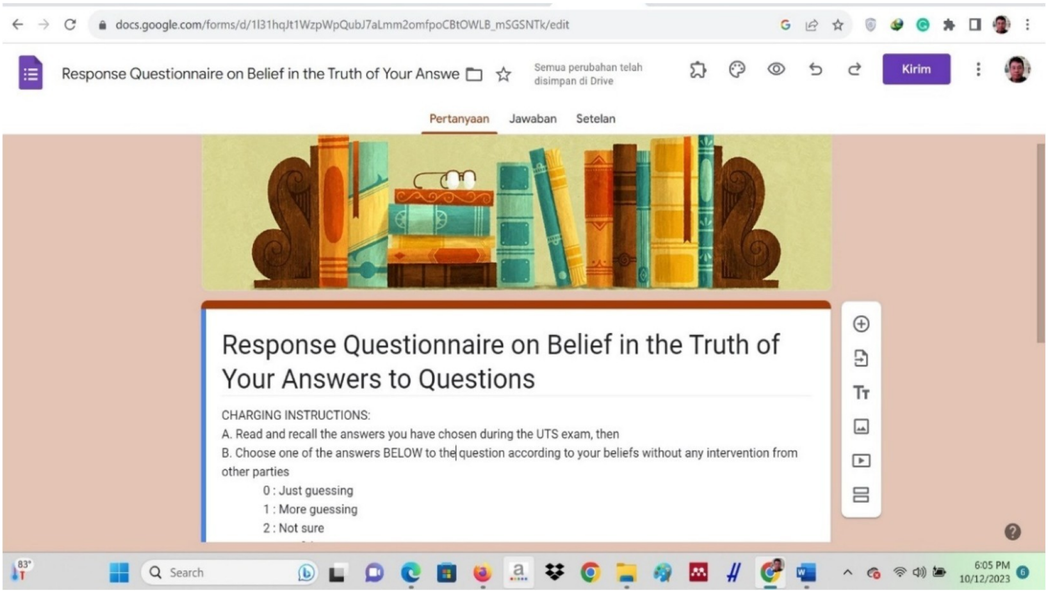

Figure 2. Diagnostic test for misconceptions via google form

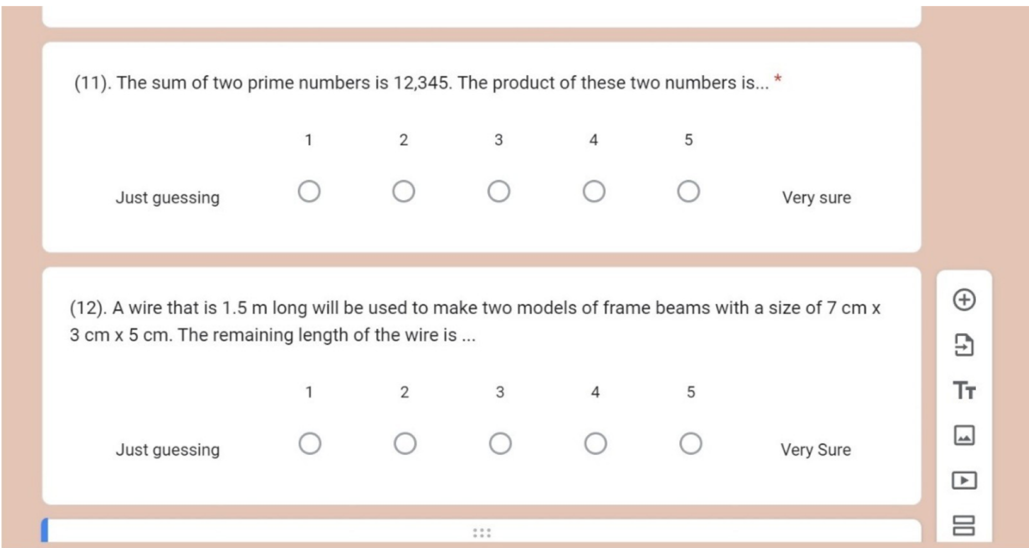

Figure 3. Sample questions for diagnostic test for misconceptions via google form

3. Results

The learning process is carried out online through Google Classroom, an online learning platform that allows teachers to create classes, share assignments, provide feedback, and interact with students online. (A'Yun, Suharso & Kantun, 2021). Following are the steps for conducting lectures using Google Classroom:

- Step 1: Create a Class in Google Classroom.

  Open Google Classroom: Visit Google Classroom and sign in using your Google account (or create an account if you don't have one). Creating a New Class: Click the + button in the top right corner and select "Create class". Fill in class information such as name, subject, and so on.

- Step 2: Adding Students to Classes

  Invite Students: Click on the class you have created. At the top, click "Invite students" and enter the student's email address or share the class code with them.

- Step 3: Create and Distribute Materials

  Manufacturing Materials: On the class page, click "Assignments" or "Materials" to create new materials. You can upload files, create assignments, or add materials from Google Drive or YouTube. Distributing Materials: After creating materials, select the classes or students who will receive them. Set a deadline for submitting assignments if necessary.

- Step 4: Interact with Students

  Providing Feedback: After students submit assignments, you can immediately provide feedback via Google Classroom. Interact via Comments: Below each assignment, there is a comments section where you and your students can interact, ask questions, or provide answers.

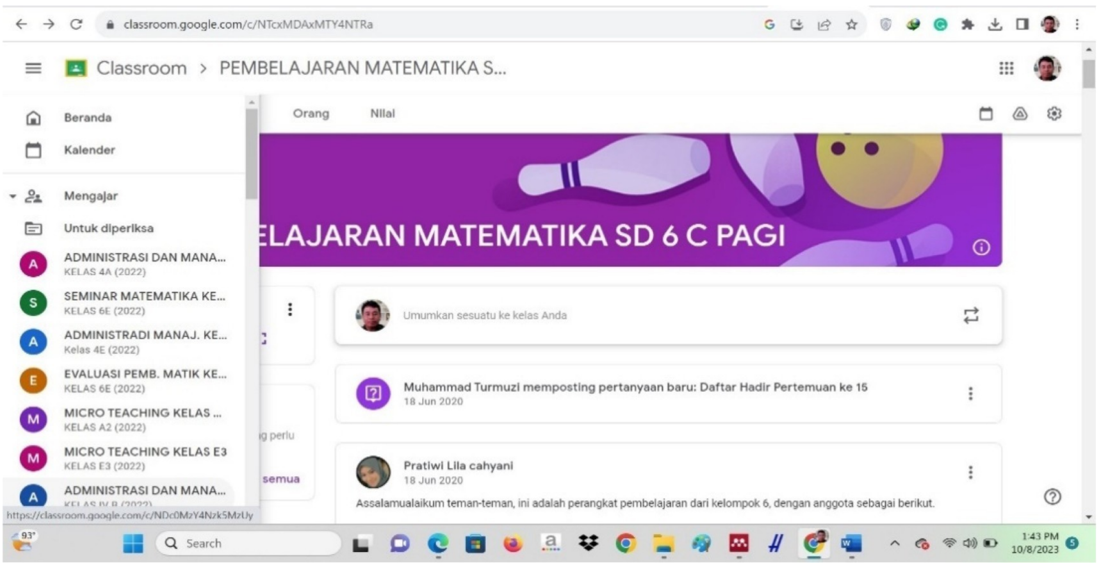

Figure 4. Learning display via google classroom

3.1. University Student Learning Style

Data on student learning styles in elementary school mathematics education courses obtained from questionnaire data. There are 36 questionnaire statement items which are divided into 3 parts, namely the visual learning style questionnaire on statement items 1 – 12; the learning style questionnaire auditory in statement items 13 – 24; and kinesthetic learning style questionnaire on items statements 25 – 36. The percentage of student learning styles is shown in Figure 5.

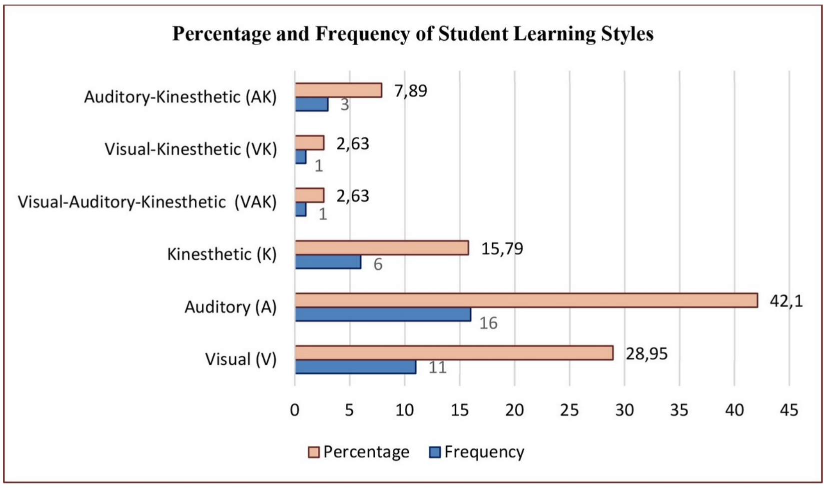

Figure 5. Percentage and frequency of student learning styles

Figure 5 depicts the frequencies and percentages of the six types of learning styles identified: Visual (V), Auditorial (A), Kinesthetic (K), Visual-Auditorial-Kinesthetic (VAK), Visual-Kinesthetic (VK), and Auditorial-Kinesthetic (AK). Frequency indicates the number of students who have a particular preference, while percentage indicates the share of the total sample (38 students) that represents each type of learning style. Visual (V): There are 11 students (28.95%) who have a visual learning style preference, which means they tend to understand information through pictures, diagrams or illustrations. Auditory (A): A total of 16 students (42.10%) have an auditory preference, which indicates that they prefer to understand the material through hearing, such as listening to oral explanations or lectures. Kinesthetic (K): Six students (15.79%) had a kinesthetic preference, meaning they understand information better through direct experience, physical activity, or practice. Visual-Auditorial-Kinesthetic (VAK): One student (2.63%) has a preference for a combination of these three types of learning styles. Visual-Kinesthetic (VK): One other student (2.63%) has both visual and kinesthetic preferences. Auditorial-Kinesthetic (AK): Three students (7.89%) had auditory and kinesthetic preferences. Thus, figure 2 provides insight into the learning style preferences of students in a particular population, which can help educators plan more effective teaching methods tailored to student needs.

According to Bosman and Schulze (2018), Chetty, Handayani, Sahabudin, Ali, Hamzah, Rahman et al. (2019), and Tzenios (2020), understanding students' learning style preferences can provide valuable guidance to educators. By knowing the best way in which students learn, educators can design more effective teaching methods. This creates a match between the way students learn and the way the material is delivered, which in turn can improve student understanding, engagement, and learning outcomes. By understanding the variations in learning styles among students in a population, educators can avoid a one-size-fits-all approach and can adapt their teaching approaches to cover a variety of learning styles (Goosen & Steenkamp, 2023; Lau & Gardner, 2019; Unhawa, Debajyoti, Chonlameth & Bunthit, 2021). This can create a more inclusive and supportive learning environment, increase student academic success, and provide a more positive learning experience overall.

3.2. Students' Concept Understanding Ability

In this section, data will be displayed on students' concept understanding abilities in terms of learning styles. The average score for understanding concepts is highest in the auditory learning style, while the score for understanding concepts is the lowest in the kinesthetic learning style. The variance in conceptual understanding ability scores for the four learning styles is quite large, this means that students' scores are very diverse and the range is quite large. The maximum scores of the four learning styles are almost the same high. The average score for each learning style can be depicted in the following Figure 6.

Figure 6 includes four types of student learning styles (Visual, Auditory, Kinesthetic, and Auditory-Kinesthetic) with several assessment metrics, including Average Score, Variance, Maximum Value, and

Minimum Score (Minimum Value). The average value of the scores obtained by students in each type of learning style. For example, the average score of students with an auditory learning style is 82.18, indicating the average score achieved by students with an auditory learning preference. Variance: Variance measures the spread of data or the extent to which student score values vary from the average score in each type of learning style. The higher the variance, the more varied the student scores in that category. Variance is a statistical measurement that indicates how far data is spread from the mean value. Maximum Value: The highest score achieved by students in each type of learning style. For example, the highest score for students with an auditory learning preference is 100. This shows that some students with an auditory preference achieve a maximum score of 100. Minimum Value: The lowest score achieved by students in each type of learning style. For example, the lowest score for students with a kinesthetic learning style is 55. This shows that there are students with kinesthetic preferences who achieve a minimum score of 55.

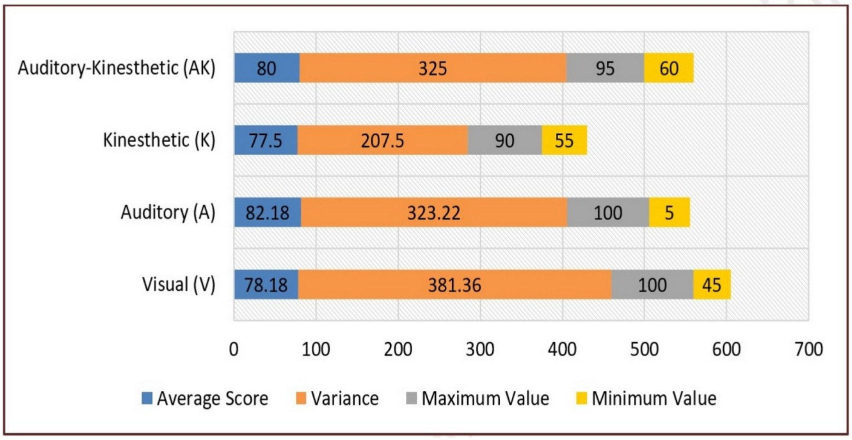

Figure 6. Summary of students' concept understanding ability judging from learning style

3.3. Students' Concept Understanding Ability Judging from Gender and Learning Style

In this section, data will be presented on students' ability to understand mathematical concepts when viewed from gender and learning style. Of the 38 students taking the Elementary Mathematics Education course, there are 31 female students and 7 male students. A summary of concept understanding abilities when viewed from gender and learning style is shown in Table 5

No.	Student Learning Style	Frequency	Gender					
			Male			Female		
			Male Frequency	Percentage	Average ($\bar{x}$)	Female Frequency	Percentage	Average ($\bar{x}$)
1.	Visual (V)	11	2	18,18%)	67,50	9	81,81%	80,55
2.	Auditory (A)	16	2	12,50%	72,50	14	87,50%	83,57
3.	Kinesthetic (K)	6	2	33,33%	72,50	4	66,66%	80
4.	Auditory-Kinesthetic (AK)	3	0	0	0	3	100%	80

Table 5. Summary of concept understanding ability if judging from gender and learning style

Table 5 provides an overview of student's ability to understand mathematical concepts based on gender and learning style. Based on this table, students' ability to understand mathematical concepts can be analyzed by combining information from the Frequency, Gender, Percentage and Average columns for each type of learning style. Students with a visual learning preference (V) have an average score of 80.55. There are 11 male students and 2 female students with visual learning preferences. Students with an auditory learning preference (A) have an average score of 83.57. There are 16 male students and 2 female students with auditory learning preferences. Students with a kinesthetic learning preference (K) have an average score of 80. There are 6 male students and 4 female students with a kinesthetic learning preference. Students with an auditory-kinesthetic (AK) learning preference have an average score of 80. There are 3 male students without any female students with an auditory-kinesthetic learning preference. Based on Table 3, students with an auditory learning preference (A) have a slightly higher average score (83.57) compared to students with a visual (V) and kinesthetic (K) learning preference who have an average score of 80. Students with an auditory-kinesthetic (AK) learning preference also had an average score of 80, however, there were no female students who had this learning preference.

Some important points that can be gleaned from these results include:

- Students with auditory preferences understand the material better through hearing, such as listening to oral explanations or lectures (Khan, Hussain-Arif & Yousuf, 2019).
- Students with auditory-kinesthetic preferences combine these two types of learning, indicating that they may be more effective in learning that involves both (Ramadian, Cahyono & Suryati, 2020; Suleiman & Akilu, 2023).
- Students with visual and kinesthetic preferences experience visual learning, such as drawing, diagrams, or illustrations, as well as hands-on experiences, physical activities, or practice (Stamm, Francetic, Reilly, Tharp, Thompson & Weidenhamer, 2021).

3.4. Student Misconceptions Viewed from Learning Style

Misconceptions are analyzed for each question item completed by students. The questions intended in this research are mid-semester exam questions. To analyze student misconceptions in elementary school mathematics education courses, researchers experienced problems, namely that there were several students who did not write down the level of confidence (Certainty of Response Index / CRI) in the questions they solved. Researchers only analyzed misconceptions in solving questions accompanied by writing the level of confidence. The following are the results of an analysis of student misconceptions in the Elementary Mathematics Education course.

Based on Table 6, the answer is correct but the CRI is low (CRI < 2.5) (A) is highest in the indicator for determining the perimeter of a flat plane shape, while the lowest is in the indicator for solving the story problems related to the smallest common factor and the greatest common factor, observing the properties -properties of quadrilaterals and determining the angles of parallel and intersecting lines. Wrong answer but low CRI (CRI < 2.5) (B) highest in the indicator determining the angles of parallel and intersecting lines, while the lowest in the indicator determining the area of a triangle, determining the perimeter of a plane figure, determining fraction algebra operations and determine the place value in the arrangement of numbers. The answer is correct but the CRI is high (CRI > 2.5) (C) is highest in the indicator for solving application problems of multiples of numbers and number factors, while it is lowest in the indicator for determining the intersection points of circles and triangles. Wrong answer (percentage of correct but high CRI (CRI > 2.5) (D) highest in the indicator of calculating the surface area of a geometric shape, solving story problems in whole numbers, while the lowest in the indicator Determining the perimeter of a flat plane shape.

Based on CRI analysis based on student answer criteria, answers true but the CRI is low (CRI < 2.5) meaning students don't know the concept (lucky guess). Wrong answer but low CRI (CRI < 2.5) means students do not know the concept. Correct answer but a high CRI (CRI > 2.5) means students master the concept well. Wrong answer but high CRI (CRI > 2.5) means student occurs misconception. Based on the data in Figure 7, 12% of students problem-solving did not know the concept (lucky guess); 18% of student problem solvers did not know the concept; 53% of student problem solvers mastered the concept well; and 17% of in solving student questions, there are misconceptions. Meanwhile, the results of the CRI analysis in terms of learning styles are shown in Figure 7.

No.	Question Indicator	A	B	C	D
1.	Find the meaning behind the notation and the concept of numbers.	2,6%	39.47%	28.95%	28.95%
2.	Execute the integer operation.	18.42%	10.53%	50%	21.05%
3.	Complete the integer operations problems in the story.	13.16%	2.63%	76.32%	7.895%
4.	Solve story problems related to Least Common Multiple and Greatest Common Factor.	0%	50%	21.05%	28.94%
5.	Identify the circle's area	5.26%	42.11%	18.42%	34.21%
6.	Look at the characteristics of quadrilaterals.	0%	18.42%	60.53%	21.05%
7.	Calculate a geometric shape's surface area.	7.89%	13.15%	36.84%	42.10%
8.	determining a tube's volume	28.95%	2.63%	55.26%	13.16%
9.	Solve whole-number word puzzles.	5.26%	39.47%	13.16%	42.11%
10.	Apply your application knowledge to multiple-number and number factor issues.	2.63%	2.63%	86.84%	7.89%
11	Determine the outcomes of the addition and multiplication of prime numbers.	13.16%	5.26%	73.68%	7.89%
12	The block's perimeter should be known.	21.05%	2.63%	73.68%	2.63%
13	calculating comparable comparison outcomes	10.53%	2.63%	84.21%	2.63%
14	Calculate the triangle's surface area.	21.05%	0%	76.32%	2.63%
15	Determine a flat shape's perimeter.	34.21%	0%	65.79%	0%
16	understand how prime numbers work and composite numbers	15.78%	2.63%	78.94%	2.63%
17.	Calculate the angles at which two lines intersect and are parallel.	0%	63.15%	10.52%	26.31%
18.	Find the location where the circle and triangle intersect.	2.63%	55.26%	2.63%	39.47%
19.	determining algebraic fractional operations	26.31%	0%	71.05%	2.63%
20.	Find the place value in a sequence of numbers.	21.05%	0%	73.68%	5.26%
Average		12,50%	17,63%	52,89%	16,97%

Notes: A. Lucky guess; B. Not knowing the concept; C. Understand the concept; D. Misconception

Table 6. CRI analysis results based on answer criteria

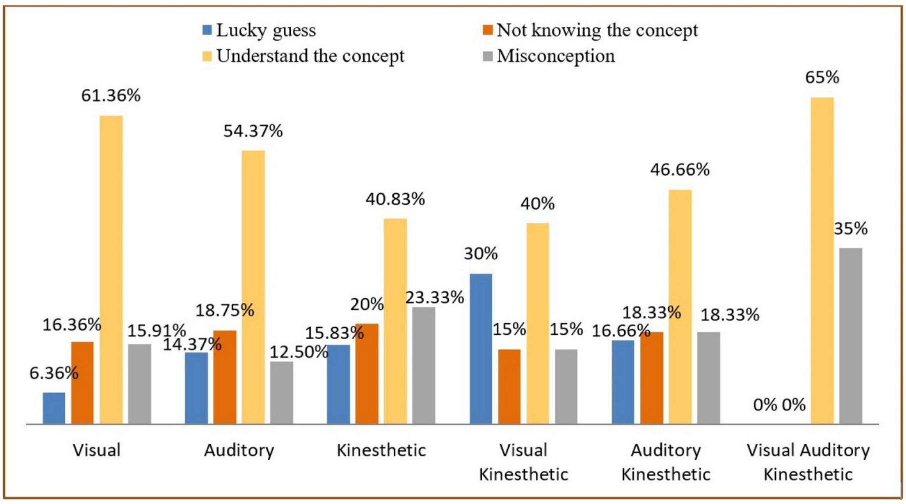

Figure 7. Percentage of CRI analysis results in view of learning style

3.5. Student Misconceptions Reviewed Gender and Learning Styles

In Figure 8, based on data on the number of male and female students in each style of unbalanced learning, then for error analysis, if viewed from the differences in gender and learning styles is only carried out on visual, auditory, and learning styles kinesthetic. The following is CRI analysis data in terms of gender and learning style.

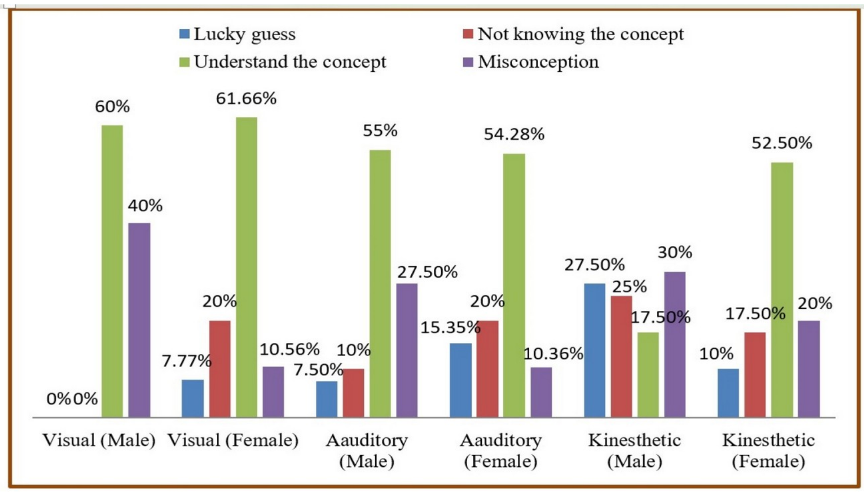

Figure 8. Percentage of CRI Analysis Results in View of Gender and Learning Style

Figure 8 provides information about learning preferences based on gender (male and female) and type of learning style (visual, auditory, and kinesthetic). Don't Know the Concept (Lucky Guess): Visual (male): 0% Visual (female): 7.77% Auditory (male): 7.50% Auditory (female): 15.35% Kinesthetic (male): 27.50% Kinesthetic (female): 10%. In this category, males in the kinesthetic learning style type have the highest percentage, indicating that they tend to use instinct or guesswork when they do not understand a concept. Meanwhile, women in the auditory learning style type have the highest percentage of using lucky guesses. Don't Know Concept: Visual (male): 0% Visual (female): 20% Auditory (male): 10% Auditory (female): 20% Kinesthetic (male): 25% Kinesthetic (female): 17.50%. In this category, men and women in the kinesthetic learning style type have the highest percentage, indicating that they tend to try to understand concepts but have not yet fully mastered them. Mastering Concepts Well: Visual (male): 60% Visual (female): 61.66% Auditory (male): 55% Auditory (female): 54.28% Kinesthetic (male): 17.50% Kinesthetic (female): 52.50%. In this category, women in the kinesthetic learning style type have the highest percentage, indicating that they tend to understand concepts well through a kinesthetic approach. Misconceptions Occur: Visual (male): 40% Visual (female): 10.56% Auditory (male): 27.50% Auditory (female): 10.36% Kinesthetic (male): 30% Kinesthetic (female): 20%. In this category, males in the kinesthetic learning style type have the highest percentage, indicating that they tend to make errors in understanding concepts. On the other hand, women in the visual learning style type have the lowest percentage, indicating that they have few misconceptions in understanding visual concepts.

This analysis illustrates that there are differences in the way men and women understand concepts based on their learning style preferences. This is also in line with the results of research from Şener and Çokçalışkan (2018) and Sagala, Umam, Thahir, Saregar and Wardani (2019), that there are differences in the way men and women understand concepts based on their learning style preferences. Men with a kinesthetic learning style are more likely to make mistakes in understanding concepts, while women with a visual learning style tend to have fewer misunderstandings in understanding visual concepts.

4. Discussion

From Figure 7 Answer option C (the correct answer with a high CRI) has a high percentage (52.89%), indicating that students tend to give the correct answer with a good understanding of this indicator. Answer options A and D have lower percentages, indicating that although the answer is correct, the student's understanding may not be deep or there is uncertainty (low CRI). Answer option B, which is a wrong answer with a low CRI, has a moderate percentage (17.63%), indicating a low understanding of this indicator. Some indicators have a low percentage of correct answers, such as indicators 1, 6, 14, and 17, indicating difficulty in understanding the material. The highest average percentage of correct answers was in answer option C (52.89%), indicating good understanding at the overall level. According to Liampa, Malandrakis, Papadopoulou and Pnevmatikos (2019) and Koto and Gusma (2021), this information can provide guidance to lecturers to assess the extent to which students understand each Certainty of Response Index (CRI) indicator and design appropriate learning strategies.

Concerning Figure 8, students who learn well visually tend to be more prevalent in the category of "Mastering concepts well." This demonstrates that pupils who have a preference for visual learning are more adept at grasping topics. Similar trends are seen in the kinesthetic and auditory domains, where most students in this category have a strong grasp of the material. Nonetheless, misconceptions affect a bigger proportion of kinesthetic learners. A significant portion of students who identify as Visual-Kinesthetic and Auditorial-Kinesthetic learn best in the category "Don't know the concept (lucky guess)." This can suggest ambiguity or perplexity among the available answers. While most students who combine Visual-Auditorial-Kinesthetic learning styles are proficient in subjects, a sizeable portion have misconceptions. This suggests that although students with this mix of learning styles could have dominating preferences, they nevertheless require extra care to avoid misunderstandings (Chen, Dewaele & Zhang, 2022; Papadatou-Pastou, Touloumakos, Koutouveli & Barrable, 2021; Smith, 2018). According to Ismajli and Imami-Morina (2018), to create more successful lessons and provide the best possible support for the development of conceptual knowledge, instructors must be aware of the learning styles that their students prefer.

The search results provide some insights into the relationship between learning styles and math conceptual errors made by students when using Google Classroom. One study found that various types of conceptual errors depend on students' learning styles (Winarso & Toheeri, 2021). Another study analyzed students' errors in learning mathematical problem-solving based on differences in their learning styles (Rushton, 2018; Hoth, Larrain & Kaiser, 2022). The study identified the relationship between learning styles and procedural errors made by students. However, the search results do not provide any information on whether there are differences in math conceptual errors between students with different learning styles when using Google Classroom specifically. Further research may be needed to explore this question (Joswick, Skultety & Olsen, 2023; Cardino & Ortega-Dela-Cruz, 2020).

Some of the research results discuss the impact of gender stereotypes and biases on students' math self-concepts and performance in the classroom (Bassi, Mateo-Díaz, Blumberg & Reynoso, 2018; Dersch, Heyder & Eitel, 2022; Wolff, 2021). These factors may indirectly influence students' mathematical misconceptions, but further research is needed to explore the specific relationship between gender differences and math misconceptions in the context of using Google Classroom. According to the search results, researchers analyzed student misconceptions in elementary school mathematics education courses by analyzing each question item completed by students in mid-semester exams (Mohyuddin & Khalil, 2016; Sujarwo, Sudiyanto, & Kurniawan, 2020; Ojose, 2015). However, some students did not write down the level of confidence (Certainty of Response Index / CRI) in the questions they solved, so researchers only analyzed misconceptions in solving questions accompanied by writing the level of confidence. The studies used different methods to identify and analyze misconceptions, such as developing a test inclusive of all the conceptual areas of mathematics from class I to Class IV, conducting a qualitative descriptive study to identify the kinds and the causal factors of misconceptions, and asking teachers to describe how they identify their students' misconceptions and how they would respond to hypothetical situations involving student misconceptions and errors. The studies aimed to identify the types of misconceptions experienced by students and the factors that contribute to these misconceptions.

Based on Figure 4, there are some differences in learning preferences based on gender and type of learning style. Here are the key findings: (a) Lucky Guess: In this category, males in the kinesthetic learning style type have the highest percentage of using instinct or guesswork when they do not understand a concept. Meanwhile, women in the auditory learning style type have the highest percentage of using lucky guesses. (b) Don't Know Concept: In this category, men and women in the kinesthetic learning style type have the highest percentage of trying to understand concepts but have not yet fully mastered them. (c) Mastering Concepts Well: In this category, women in the kinesthetic learning style type have the highest percentage of understanding concepts well through a kinesthetic approach. (c) Misconceptions Occur: In this category, males in the kinesthetic learning style type have the highest percentage of making errors in understanding concepts. On the other hand, women in the visual learning style type have the lowest percentage of having misconceptions in understanding visual concepts. It is important to note that these findings are based on a limited dataset and may not be generalizable to all students. Additionally, the concept of learning styles has been debated, and some researchers consider it a myth. Nonetheless, understanding the preferences of students can still be beneficial for creating a diverse and inclusive learning environment (Sarabi-Asiabar, Jafari, Sadeghifar, Tofighi, Zaboli, Peyman et al., 2015; Wehrwein, Lujan & DiCarlo, 2007; Bin-Eid, Almutairi, Alzahrani, Alomair, Albinhamad, Albarrak et al., 2021; Hamidon, 2015; Munir & Azizan, 2015). The idea of learning styles, such as visual, auditory, and kinesthetic, has been widely discussed in education. However, recent research has debunked the myth that matching instruction to students' preferred learning styles enhances learning outcomes. While students may have individual preferences for how they receive information, there is no strong evidence to support the notion that tailoring instruction to these preferences leads to better understanding or performance (Newton & Miah, 2017; Ratnaningsih & Hidayat, 2020).

5. Conclusion

The conclusion of this study shows that students' concept comprehension abilities differ based on their learning styles. The average level of understanding of students' concepts from high to low is as follows: (a) Visual learning style (78.18); (b) Auditory learning style (82.18); (c) Kinesthetic learning style (77.50); and (d) Auditory-kinesthetic learning style (80.00). Meanwhile, the analysis showed that students' understanding of concepts was also influenced by gender. Women tend to have a better understanding of concepts than men in every learning style, except for kinesthetic learning styles where men have a slightly better understanding. CRI (Critical Response Index) analysis shows that most students are able to master concepts well, but there is still a small percentage of students who have misunderstandings. For example, students with visual learning styles tend to have a better level of understanding of concepts, whereas students with kinesthetic learning styles.

The study indicates variations in learning styles between genders. For example, females tend to perform better as visual learners, while males show strength in auditory learning. Educators should be aware of these differences and consider implementing gender-specific teaching strategies to enhance engagement and understanding among male and female students. Further research can be conducted to delve deeper into the reasons behind the observed gender-based and learning style-based differences in conceptual understanding. Understanding the underlying causes can aid in the development of more targeted and effective teaching strategies.

Regular assessments should be conducted to identify students' understanding levels and learning style preferences. This data can help in adapting teaching methods and providing timely feedback to students. Adjustments in teaching techniques can be made based on the assessment results, ensuring that students receive tailored support

6. Recommendations

Based on the provided research conclusions, the following recommendations can be made:

- Educators should employ teaching methods that cater to different learning styles. For instance, visual learners tend to grasp concepts better through visual aids and graphics, while auditory learners benefit from lectures and discussions. Kinesthetic learners may require hands-on activities. Teachers can incorporate a mix of these methods in their lessons to accommodate diverse learning styles.

- A significant portion of students (21.69% overall) face misconceptions when learning. Teachers should focus on identifying and addressing these misconceptions early on. Targeted interventions, one-on-one sessions, or additional resources can be provided to students who exhibit misconceptions, ensuring they grasp the correct concepts.
- Kinesthetic learners, who learn best through hands-on activities, may benefit from interactive and participatory classroom activities. Encouraging group discussions, experiments, and projects can engage these learners effectively, leading to a deeper understanding of the concepts.
- Teachers should be provided with professional development opportunities to enhance their understanding of diverse learning styles and effective teaching methods. Workshops and training sessions can equip educators with the necessary skills to create inclusive classrooms that accommodate various learning preferences.
- Educate parents about the different learning styles and involve them in their child's education. When parents are aware of their child's learning style, they can provide additional support and resources at home that align with the child's learning preferences.

The research presented in the conclusions has several limitations: The study's findings are specific to a particular group of students, in a particular context, and may not be generalized to a broader population. The results might differ if the study is conducted in different settings or with diverse student populations. The classification of learning styles into visual, auditory, kinesthetic, and auditory-kinesthetic is oversimplified. Learning styles are complex and can involve various other factors, such as social, emotional, and cultural aspects. This oversimplification may not fully capture the intricacies of how students learn. The study might suffer from a small sample size, which can limit the reliability and generalizability of the results. A larger and more diverse sample is necessary to draw robust conclusions about the relationship between learning styles, gender, and conceptual understanding. The research may not have controlled for external variables that could influence the results, such as socioeconomic status, prior educational experiences, or cultural background. These variables can significantly impact students' learning styles and conceptual understanding. The study might rely on self-reported data regarding learning styles, which can be subjective and influenced by social desirability bias. Objective measures, such as observation or physiological data, could provide a more accurate assessment of learning styles.

Declaration of Conflicting Interests

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References

A'Yun, K., Suharso, P., & Kantun, S. (2021). Google Classroom as the Online Learning Platform during he Covid-19 Pandemic for the Management Business Student at SMK Negeri 1 Lumajang. *IOP Conference Series: Earth and Environmental Science*, 747(1). https://doi.org/10.1088/1755-1315/747/1/012025

Ahmadi, S., Keshavarzi, A., & Foroutan, M. (2011). The application of information and communication technologies (ict) and its relationship with improvement in teaching and learning. *Procedia - Social and Behavioral Sciences*, 28, 475-480. https://doi.org/10.1016/j.sbspro.2011.11.091

Alcaro, A., Carta, S., & Panksepp, J. (2017). The affective core of the self: A neuro-archetypical perspective on the foundations of human (and Animal) subjectivity. *Frontiers in Psychology*, 8(SEP), 1-13. https://doi.org/10.3389/fpsyg.2017.01424

Basher, S.A.O. (2017). The impact of google classroom application on the teaching efficiency of pre-teachers. *International Journal of Social Sciences and Education*, 2(2), 45-54.

Bassi, M., Mateo-Díaz, M., Blumberg, R.L., & Reynoso, A. (2018). Failing to notice? Uneven teachers' attention to boys and girls in the classroom. *IZA Journal of Labor Economics*, 7(1). https://doi.org/10.1186/s40172-018-0069-4

Bergström, P., & Wiklund-Engblom, A. (2022). Who's got the power? Unpacking three typologies of teacher practice in one-to-one computing classrooms in Finland. *Computers and Education*, 178. https://doi.org/10.1016/j.compedu.2021.104396

Bin-Eid, A., Almutairi, M., Alzahrani, A., Alomair, F., Albinhamad, A., Albarrak, Y. et al. (2021). Examining learning styles with gender comparison among medical students of a saudi university. *Advances in Medical Education and Practice*, 12, 309-318. https://doi.org/10.2147/AMEP.S295058

Boateng, G.O., Neilands, T.B., Frongillo, E.A., Melgar-Quiñonez, H.R., & Young, S.L. (2018). Best Practices for Developing and Validating Scales for Health, Social, and Behavioral Research: A Primer. *Frontiers in Public Health*, 6(June), 1-18. https://doi.org/10.3389/fpubh.2018.00149

Borova, T., Chekhratova, O., Marchuk, A., Pohorielova, T., & Zakharova, A. (2021). Fostering Students' Responsibility and Learner Autonomy by Using Google Educational Tools. *Revista Romaneasca Pentru Educatie Multidimensionala*, 13(3), 73-94. https://doi.org/10.18662/rrem/13.3/441

Bosman, A., & Schulze, S. (2018). Learning style preferences and mathematics achievement of secondary school learners. *South African Journal of Education*, 38(1), 1-8. https://doi.org/10.15700/saje.v38n1a1440

Bringula, R., Reguyal, J.J., Tan, D.D., & Ulfa, S. (2021). Mathematics self-concept and challenges of learners in an online learning environment during COVID-19 pandemic. *Smart Learning Environments*, 8(1). https://doi.org/10.1186/s40561-021-00168-5

Bujang, M.A., Omar, E.D., & Baharum, N.A. (2018). A review on sample size determination for cronbach's alpha test: A simple guide for researchers. *Malaysian Journal of Medical Sciences*, 25(6), 85-99. https://doi.org/10.21315/mjms2018.25.6.9

Busetto, L., Wick, W., & Gumbinger, C. (2020). How to use and assess qualitative research methods. *Neurological Research and Practice*, 2(1). https://doi.org/10.1186/s42466-020-00059-z

Cardino, J.M., & Ortega-Dela-Cruz, R.A. (2020). Understanding of learning styles and teaching strategies towards improving the teaching and learning of mathematics. *Lumat*, 8(1), 19-43. https://doi.org/10.31129/LUMAT.8.1.1348

Chen, X., Dewaele, J.M., & Zhang, T. (2022). Sustainable development of EFL/ESL learners' willingness to communicate: The effects of teachers and teaching styles. *Sustainability (Switzerland)*, 14(1), 1-21. https://doi.org/10.3390/su14010396

Chetty, N.D.S., Handayani, L., Sahabudin, N.A., Ali, Z., Hamzah, N., Rahman, N.S.A. et al. (2019). Learning styles and teaching styles determine students' academic performances. *International Journal of Evaluation and Research in Education*, 8(4), 610-615. https://doi.org/10.11591/ijere.v8i3_

Cohen, A., Oxford, R., & Chi, J. (2006). Learning style survey: Assessing your own learning styles. *Maximizing Study Abroad: An Instructional Guide to Strategies for Language and Culture Learning and Use* (153-161). https://carla.umn.edu/maxsa/documents/LearningStyleSurvey_MAXSA_IG.pdf

Delić-Zimić, A., & Gadžo, N. (2018). Implementation of ICT in Education. *Lecture Notes in Networks and Systems*, 28, 215-222. https://doi.org/10.1007/978-3-319-71321-2_18

Dersch, A.S., Heyder, A., & Eitel, A. (2022). Exploring the Nature of Teachers' Math-Gender Stereotypes: The Math-Gender Misconception Questionnaire. *Frontiers in Psychology*, 13(April), 1-14. https://doi.org/10.3389/fpsyg.2022.820254

Eccles, J.S. (1994). Understanding Women's Educational And Occupational Choices. *Psychology of Women Quarterly*, 18, 585-609. https://doi.org/10.1111/j.1471-6402.1994.tb01049.x

Ecclestone, K., Hall, E., Coffield, F., & Moseley, D. (2004). Learning styles and pedagogy in post 16 education: a critical and systematic review. *International Journal of Clinical Legal Education Editorials*.

Else-Quest, N.M., Hyde, J.S., & Linn, M.C. (2010). Cross-National Patterns of Gender Differences in Mathematics: A Meta-Analysis. *Psychological Bulletin*, 136(1), 103-127. https://doi.org/10.1037/a0018053

Felder, R.M., & Silverman, L.K. (1988). Learning and Teaching Styles in Engineering Education. *Journal of Engineering Education*, 78(7), 674-681. Available at: https://www.engr.ncsu.edu/wp-content/uploads/drive/1QP6kBI1iQmpQbTXL-08HSl0PwJ5BYnZW/1988-LS-plus-note.pdf

Feldman, M.Q., Cho, J.Y., Ong, M., Gulwani, S., Popovic, Z., & Andersen, E. (2018). Automatic diagnosis of students' misconceptions in K-8 mathematics. *Conference on Human Factors in Computing Systems - Proceedings* (1-12). https://doi.org/10.1145/3173574.3173838

Firmasari, S., & Nopriana, T. (2020). The certainty of Response Index (CRI) and scale of honesty to identify student misconceptions. *Journal of Physics: Conference Series*, 1511(1). https://doi.org/10.1088/1742-6596/1511/1/012114

Fleming, N.D. (1992). Not Another Inventory, Rather a Catalyst for Reflection. *To Improve the Academy*, 11(20210331). https://doi.org/10.3998/tia.17063888.0011.014

Franke, G., & Sarstedt, M. (2019). Heuristics versus statistics in discriminant validity testing: a comparison of four procedures. *Internet Research*, 29(3), 430-447. https://doi.org/10.1108/IntR-12-2017-0515

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: Interviews and focus groups. *British Dental Journal*, 204(6), 291-295. https://doi.org/10.1038/bdj.2008.192

Goosen, R., & Steenkamp, G. (2023). Activating accounting students' decision-making skills through a reflective self-assessment workshop on learning styles. *International Journal of Management Education*, 21(3), 100858. https://doi.org/10.1016/j.ijme.2023.100858

Gray, L., & Lewis, L. (2021). Use of educational technology for instruction in public schools: 2019-20. *U.S. Department of Education*, 017. Available at: https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2021017

Gunderson, E.A., Ramirez, G., Levine, S.C., & Beilock, S.L. (2012). The Role of Parents and Teachers in the Development of Gender-Related Math Attitudes. *Sex Roles*, 66(3-4), 153-166. https://doi.org/10.1007/s11199-011-9996-2

Gupta, A., & Fisher, D. (2012). Technology-supported learning environments in science classrooms in India. *Learning Environments Research*, 15(2), 195-216. https://doi.org/10.1007/s10984-012-9103-9

Gupta, A., & Pathania, P. (2021). To study the impact of Google Classroom as a platform of learning and collaboration at the teacher education level. *Education and Information Technologies*, 26(1), 843-857. https://doi.org/10.1007/s10639-020-10294-1

Hamidon, N.A.B. (2015). Study on Students Learning Style According to Gender Factor. *Journal of Culture, Society and Development*, 8(2002), 20-22.

Hasan, S., Bagayoko, D., & Kelley, E.L. (1999). Misconceptions and the certainty of response index (CRI). *Physics Education*, 34(5), 294-299. https://doi.org/10.1088/0031-9120/34/5/304

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81-112. https://doi.org/10.3102/003465430298487

Heggart, K.R., & Yoo, J. (2018). Getting the most from google classroom: A pedagogical framework for tertiary educators. *Australian Journal of Teacher Education*, 43(3), 140-153. https://doi.org/10.14221/ajte.2018v43n3.9

Hoth, J., Larrain, M., & Kaiser, G. (2022). Identifying and dealing with student errors in the mathematics classroom: Cognitive and motivational requirements. *Frontiers in Psychology*, 13(December), 1-16. https://doi.org/10.3389/fpsyg.2022.1057730

Hussein-Ibrahim, R., & Hussein, D.A. (2015). Assessment of visual, auditory, and kinesthetic learning style among undergraduate nursing students. *International Journal of Advanced Nursing Studies*, 5(1), 1. https://doi.org/10.14419/ijans.v5i1.5124

Hyde, J.S., Fennema, E., & Lamon, S.J. (2010). Gender differences in mathematics performance. *Psychological Bulletin*, 107(2), 139-155. https://doi.org/10.1787/9789264091450-graph36-en

Ismajli, H., & Imami-Morina, I. (2018). Differentiated instruction: Understanding and applying interactive strategies to meet the needs of all the students. *International Journal of Instruction*, 11(3), 207-218. https://doi.org/10.12973/iji.2018.11315a

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

Joswick, C., Skultety, L., & Olsen, A.A. (2023). Education sciences Mathematics, Learning Disabilities, and Learning Styles : A Review of Perspectives Published by the National Council of Teachers of Mathematics. *Education Sciences*, 13(1023), 1-17. https://doi.org/10.3390/educsci13101023

Kamal, I., Karim, M.K.A., Kechik, M.M.A., Ni, X., & Razak, H.R.A. (2021). Evaluation of healthcare science student learning styles based vark analysis technique. *International Journal of Evaluation and Research in Education*, 10(1), 255-261. https://doi.org/10.11591/ijere.v10i1.20718

Khan, S.A., Hussain-Arif, M., & Yousuf, M.I. (2019). A Study of Relationship between Learning Preferences and Academic Achievement LPs of College Students in PP (Pakistan) and Relationship with their AA 18. *Bulletin of Education and Research*, 41(1), 17-32. Available at: http://pu.edu.pk/home/journal/32

Knekta, E., Runyon, C., & Eddy, S. (2019). One size doesn't fit all: Using factor analysis to gather validity evidence when using surveys in your research. *CBE Life Sciences Education*, 18(1), 1-17. https://doi.org/10.1187/cbe.18-04-0064

Kolb, D.A. (1984). The Process of Experiential Learning: In *Strategic Learning in a Knowledge Economy* (313-331). https://doi.org/10.1016/B978-0-7506-7223-8.50017-4

Koto, I., & Gusma, S.E. (2021). Using certainty response index to differentiate lack of knowledge and misconception about basic electrical concepts. *Journal of Physics: Conference Series*, 1731(1). https://doi.org/10.1088/1742-6596/1731/1/012070

Latif, F.H., Mursalin, Buhungo, T.J., & Odja, A.H. (2021). Analysis of Students' Misconceptions Using the Certainty of Response Index (CRI) on the Concept of Work and Energy in SMA Negeri 1 Gorontalo Utara After Online Learning. *Proceedings of the 7th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS 2020)* (511-515). https://doi.org/10.2991/assehr.k.210305.075

Lau, K., & Gardner, D. (2019). Disciplinary variations in learning styles and preferences: Implications for the provision of academic English. *System*, 80, 257-268. https://doi.org/10.1016/j.system.2018.12.010

Liampa, V., Malandrakis, G.N., Papadopoulou, P., & Pnevmatikos, D. (2019). Development and Evaluation of a Three-Tier Diagnostic Test to Assess Undergraduate Primary Teachers' Understanding of Ecological Footprint. *Research in Science Education*, 49(3), 711-736. https://doi.org/10.1007/s11165-017-9643-1

Mishra, L. (2020). Conception and misconception in teaching arithmetic at primary level. *Journal of Critical Reviews*, *7*(5), 936-939. https://doi.org/10.31838/jcr.07.05.192

Mohyuddin, R.G., & Khalil, U. (2016). Misconceptions of students in learning mathematics at primary level. *Bulletin of Education and Research*, 38(1), 133-162.

Munir, S., & Azizan, S.N. (2015). Learning Style Preferences Among Male and Female ESL Students in Universiti-Sains Malaysia. *Journal of Educators Online (JEO)*, 13(2), 142-166. https://doi.org/10.9743/JEO.2015.2.3

Naeem-Ahmed, S., & ur Rehman, S. (2021). An Examination of Students' Attitude towards the Use of Google Classroom in Preparatory Year English Program. *Bulletin of Education and Research,* 43(2), 39-59.

Newton, P.M., & Miah, M. (2017). Evidence-based higher education - Is the learning styles "myth" important? *Frontiers in Psychology*, 8, 1-9. https://doi.org/10.3389/fpsyg.2017.00444

Newton, T. (1984). VAK Learning Styles Self-Assessment Questionnaire. *Nurse Education Today*, 4(5), 115-116. https://doi.org/10.1016/S0260-6917(84)80029-5

Nwobi, A., Ngozi, U., Rufina, N., & Ogbonnaya, K.A. (2016). Implementation of Information Communication Technology in the Teaching/Learning Process for Sustainable Development of Adults in West Africa Sub Sahara Region. *Journal of Education and Practice*, 7(21), 14-19. Available at: http://iiste.org/Journals/index.php/JEP

Ojose, B. (2015). Students' Misconceptions in Mathematics: Analysis of Remedies and What Research Says. *Ohio Journal of School Mathematics*, 72, 30-34. Available at: http://hdl.handle.net/1811/78927

Pajares, F. (2004). Gender differences in mathematics self-efficacy beliefs. *Gender Differences in Mathematics: An Integrative Psychological Approach*, 44(9), 294-315. https://doi.org/10.1017/CBO9780511614446.015

Papadatou-Pastou, M., Touloumakos, A.K., Koutouveli, C., & Barrable, A. (2021). The learning styles neuromyth: when the same term means different things to different teachers. *European Journal of Psychology of Education*, 36(2), 511-531. https://doi.org/10.1007/s10212-020-00485-2

Parwati, N.N., & Suharta, I.G.P. (2020). Effectiveness of the implementation of cognitive conflict strategy assisted by e-service learning to reduce students' mathematical misconceptions. *International Journal of Emerging Technologies in Learning*, 15(11), 102-118. https://doi.org/10.3991/IJET.V15I11.11802

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles concepts and evidence. *Psychological Science in the Public Interest, Supplement*, *9*(3), 105–119. https://doi.org/10.1111/j.1539-6053.2009.01038.x

Radmehr, F., & Goodchild, S. (2022). Switching to Fully Online Teaching and Learning of Mathematics: The Case of Norwegian Mathematics Lecturers and University Students During the Covid-19 Pandemic. In *International Journal of Research in Undergraduate Mathematics Education,* 8 (3). Springer International Publishing. https://doi.org/10.1007/s40753-021-00162-9

Rahman, M.S. (2016). The Advantages and Disadvantages of Using Qualitative and Quantitative Approaches and Methods in Language "Testing and Assessment" Research: A Literature Review. *Journal of Education and Learning*, 6(1), 102. https://doi.org/10.5539/jel.v6n1p102

Rakes, C.R., & Ronau, R.N. (2019). Rethinking mathematics misconceptions: Using knowledge structures to explain systematic errors within and across content domains. *International Journal of Research in Education and Science*, 5(1), 1-21. https://doi.org/10.13016/M2NB41-XJTL

Ramadian, O.D., Cahyono, B.Y., & Suryati, N. (2020). The Implementation of Visual, Auditory, Kinesthetic (VAK) Learning Model in Improving Students' Achievement in Writing Descriptive Texts. *English Language Teaching Educational Journal*, 2(3), 142. https://doi.org/10.12928/eltej.v2i3.946

Ratnaningsih, N., & Hidayat, E. (2020). Reflective mathematical thinking process and student errors: An analysis in learning style. *Journal of Physics: Conference Series*, 1613(1), 0-7. https://doi.org/10.1088/1742-6596/1613/1/012037

Roberts, K., Dowell, A., & Nie, J.B. (2019). Attempting rigour and replicability in thematic analysis of qualitative research data; A case study of codebook development. *BMC Medical Research Methodology*, 19(1), 1-8. https://doi.org/10.1186/s12874-019-0707-y

Rushton, S.J. (2018). Teaching and learning mathematics through error analysis. *Fields Mathematics Education Journal*, 3(1), 1-12. https://doi.org/10.1186/s40928-018-0009-y

Sagala, R., Umam, R., Thahir, A., Saregar, A., & Wardani, I. (2019). The effectiveness of stem-based on gender differences: The impact of physics concept understanding. *European Journal of Educational Research*, 8(3), 753-761. https://doi.org/10.12973/eu-jer.8.3.753

Sarabi-Asiabar, A., Jafari, M., Sadeghifar, J., Tofighi, S., Zaboli, R., Peyman, H. et al. (2015). The relationship between learning style preferences and gender, educational major and status in first year medical students: A survey study from Iran. *Iranian Red Crescent Medical Journal*, 17(1), 1-6. https://doi.org/10.5812/ircmj.18250

Schnepper, L.C., & Mccoy, L.P. (2017). Analysis of Misconceptions in High School Mathematics. *Networks: An Online Journal for Teacher Research Volume*, 15(1). https://doi.org/10.4148/2470-6353.1066

Seixas, B.V., Smith, N., & Mitton, C. (2018). The qualitative descriptive approach in international comparative studies: Using online qualitative surveys. *International Journal of Health Policy and Management*, 7(9), 778-781. https://doi.org/10.15171/ijhpm.2017.142

Şener, S., & Çokçalışkan, A. (2018). An Investigation between Multiple Intelligences and Learning Styles. *Journal of Education and Training Studies*, 6(2), 125. https://doi.org/10.11114/jets.v6i2.2643

Sivaprasad, S., Tschosik, E., Kapre, A., Varma, R., Bressler, N.M., Kimel, M. et al. (2018). Reliability and Construct Validity of the NEI VFQ-25 in a Subset of Patients With Geographic Atrophy From the Phase 2 Mahalo Study. *American Journal of Ophthalmology*, 190, 1-8. https://doi.org/10.1016/j.ajo.2018.03.006

Smith, B. (2018). Generalizability in qualitative research: misunderstandings, opportunities and recommendations for the sport and exercise sciences. *Qualitative Research in Sport, Exercise and Health*, 10(1), 137-149. https://doi.org/10.1080/2159676X.2017.1393221

Soroush, A., Andaieshgar, B., Vahdat, A., & Khatony, A. (2021). The characteristics of an effective clinical instructor from the perspective of nursing students: a qualitative descriptive study in Iran. *BMC Nursing*, 20(1), 1-9. https://doi.org/10.1186/s12912-021-00556-9

St John, W., & Johnson, P. (2000). The pros and cons of data analysis software for qualitative research. *Journal of Nursing Scholarship*, 32(4), 393-397. https://doi.org/10.1111/j.1547-5069.2000.00393.x

Stamm, M., Francetic, K., Reilly, R., Tharp, A., Thompson, N., & Weidenhamer, R. (2021). Kinesthetic Learners During the COVID-19 Pandemic: Occupational Therapy Students' Perspective on E-learning. *Journal of Occupational Therapy Education*, 5(2). https://doi.org/10.26681/jote.2021.050203

Sujarwo, M., Sudiyanto, & Kurniawan, S.B. (2020). Analysis on Mathematics Learning Misconceptions of the Second-Grade Students of Elementary School in Addition and Subtraction Integer Topics. *Advances in Social Science, Education and Humanities Research*, 397, 757-764. https://doi.org/10.2991/assehr.k.200129.095

Suleiman, S.M., & Akilu, I. (2023). Effect of Flipped Classroom Instruction and Enhanced Lecture Method on Academic Performance in Genetics Among Students with Visual-Auditory-Kinesthetic (VAK) Learning Styles in Gusau, Zamfara State, Nigeria. *Journal of Science, Technology and Mathematics*, 1(2), 1-20. Available at: https://jostmp-ksu.com.ng/index.php/jostmp/article/view/63

Syofyan, R., & Siwi, M.K. (2018). The Impact of Visual, Auditory, and Kinesthetic Learning Styles on Economics Education Teaching. *Advances in Economics, Business and Management Research*, 57(Piceeba), 642-649. https://doi.org/10.2991/piceeba-18.2018.17

Taber, K.S. (2018). The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education. *Research in Science Education*, 48(6), 1273-1296. https://doi.org/10.1007/s11165-016-9602-2

Tonui, B., Kerich, R., & Koross, R. (2017). Implementation of ICT in Kenya Primary Schools in the Light of Free Laptops at Primary One, Challenges and Possibilities (A Case Study of Teachers in Nandi County Kenya Implementing ICT into Their Teaching Practice). *NASPA Journal*, 7(13), 1. Available at: https://iiste.org/Journals/index.php/JEP/article/view/30615

Tzenios, N. (2020). Clustering Students for Personalized Health Education Based on Learning Styles. *Sage Science Review of Educational Technology*, 3(1), 22-36. Available October https://journals.sagescience.org/index.php/ssret/article/view/22

Unhawa, N., Debajyoti, P., Chonlameth, A., & Bunthit, W. (2021). Unified Model for Learning Style Recommendation. *Journal of Web Engineering*, 20(5), 1003-1026. https://doi.org/10.13052/jwe1540-9589.2058

Wehrwein, E.A., Lujan, H.L., & DiCarlo, S.E. (2007). Gender differences in learning style preferences among undergraduate physiology students. *American Journal of Physiology - Advances in Physiology Education*, 31(2), 153-157. https://doi.org/10.1152/advan.00060.2006

Winarso, W., & Toheeri, T. (2021). An Analysis of Students' Error in Learning Mathematical Problem Solving; the Perspective of David Kolb's Theory. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, February. https://doi.org/10.16949/turkbilmat.753899

Wolff, F. (2021). How Classmates' Gender Stereotypes Affect Students' Math Self-Concepts: A Multilevel Analysis. *Frontiers in Psychology*, 12(May). https://doi.org/10.3389/fpsyg.2021.599199

Wong, L.P. (2008). Data analysis in qualitative research: A brief guide to using NVIVO. *Malaysian Family Physician*, 3(1), 14-20. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4267019/

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