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Uncovering Mathematical Literacy Ability of Eighth Grade Junior High School Students Based on VARK Learning Style

Eksplorasi Kemampuan Literasi Matematis Siswa SMP Kelas VIII Berdasarkan Gaya Belajar VARK

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Abstract

This study explores the mathematical literacy skills of eighth-grade students based on their learning styles using the VARK model (Visual, Auditory, Read/Write, Kinesthetic). A descriptive qualitative approach was employed, involving 23 junior high school students in one of the districts in Southeast Sulawesi, Indonesia. Five informants representing auditory, read/write, kinesthetic, auditory-read/write-kinesthetic, and visual-read/write-kinesthetic types were selected through purposive sampling. Data were collected through mathematical literacy tasks and unstructured interviews. The findings reveal that learning styles influence mathematical literacy, including communication, modeling, representation, and problem-solving skills. Auditory learners excelled in all stages, while read/write and kinesthetic learners struggled, particularly in communication and problem-solving. Multimodal learners demonstrated greater flexibility.

Keywords: *Junior High School; Learning Style; Mathematics Learning; Mathematics Literacy; VARK Style.*

Abstrak

Penelitian ini mengeksplorasi keterampilan literasi matematika siswa kelas VIII berdasarkan gaya belajar mereka menggunakan model VARK (Visual, Auditori, Membaca/Menulis, Kinestetik). Pendekatan kualitatif deskriptif digunakan dengan melibatkan 23 siswa SMP di salah satu kabupaten yang ada di Sulawesi Tenggara, Indonesia. Selanjutnya, lima siswa dipilih secara purposive sampling sebagai informan penelitian mewakili gaya belajar tipe auditori, membaca/menulis, kinestetik, auditori membaca/menulis-kinestetik, dan visual-membaca/menulis-kinestetik. Pengumpulan data dilakukan melalui tugas literasi matematika dan wawancara tidak terstruktur. Hasil penelitian menunjukkan bahwa gaya belajar memengaruhi literasi matematika, termasuk kemampuan komunikasi, pemodelan, representasi, dan pemecahan masalah. Siswa auditori unggul dalam semua tahapan, siswa dengan gaya belajar membaca/menulis dan kinestetik mengalami kesulitan terutama dalam komunikasi dan pemecahan masalah, sementara pembelajar multimodal lebih fleksibel.

Kata Kunci: *Gaya Belajar; Literasi Matematika; Model VARK; Pembelajaran Matematika; SMP.*

Introduction

Mathematical literacy is an important competency that students must master in the modern era. Mathematical literacy refers to the ability of individuals to formulate, apply, and interpret mathematics in various contexts of daily life [1]. This ability includes basic numeracy skills and the ability to solve problems, reason, communicate, and model situations using mathematical concepts [2]. Mathematical literacy allows students to apply mathematical knowledge in real-world contexts, fostering critical thinking and problem-solving skills [3]. Research shows that students' mathematical literacy skills vary at different levels, with higher abilities showing better communication and problem-solving skills [4]. Developing strong mathematical literacy skills is essential for students to effectively apply mathematical concepts in real-world contexts and solve everyday challenges [5].

The increased focus on mathematical literacy in the global education system is driving research on the factors that influence the development of these skills. Various studies show that connecting mathematical concepts with real-life contexts is essential for developing numeracy skills [6]. For students in

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junior high school, the complexity of math tasks is often a challenge in connecting theory with practice. Many students have difficulty connecting these concepts, so they often show low levels of mathematical literacy [7]. This gap is influenced by various factors, including the student's learning style. Considering the diverse learning styles in mathematics education is important to improve students' mathematical literacy and problem-solving abilities [8]. Research shows that learning styles significantly affect students' mathematical literacy processes and problem-solving abilities [9]. Therefore, exploring how different learning styles affect mathematical literacy is important.

Learning style refers to an individual's preferences in thinking and processing information, usually categorized as visual, auditory, or tactile/kinesthetic [10]. Learning styles include visual, auditory, and kinesthetic; some include read/write [11]. Learning styles affect students' mathematical comprehension and problem-solving abilities, with visual learners excelling in graphic tasks, auditory learners in verbal instruction, and kinesthetic learners in hands-on activities [12]. Research shows that learning styles affect critical

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thinking skills in mathematics [13]. Aligning teaching strategies with students' perceptual learning styles can create a thriving learning environment, ultimately improving general learning skills, logical reasoning, and problem-solving abilities in mathematics [14].

Several studies have examined the issue of literacy skills along with cognitive styles; for example, Trisnaningtyas and Khotimah revealed the mathematical literacy skills of grade X students at high school in working on the Minimum Competency Assessment questions reviewed from the student's learning style [15]. Rismen et al analyzed the mathematical literacy ability of grade VII junior high school students from their learning styles [16]. Meanwhile, Himmi et al. revealed the mathematical literacy ability of grade X students at vocational high schools based on visual learning styles [17].

However, a research gap exists in exploring mathematical literacy at the junior high school level from the perspective of students' learning styles. Studies by Trisnaningtyas and Khotimah and Himmi et al. have focused on high school and vocational school levels, which differ significantly from junior high school in terms of educational characteristics [18]. Vocational school students, for instance, often have a specialized focus on mathematics. While Risman et al., conducted research at the junior high school level, the learning style framework employed differs from that of the current study [19]. This research utilizes the VARK model (Visual, Auditory, Reade/Write, Kinesthetic), in contrast to the AVK model (Audio, Visual, Kinesthetic) used in previous studies. Moreover, this study extends the analysis by categorizing student

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abilities based on combinations of learning styles, offering a more nuanced understanding of how these styles intersect with mathematical literacy skills.

This study is innovative in its approach by utilizing a combination of learning styles to categorize the mathematical literacy skills of eighth-grade junior high school students. The primary objective is to investigate the mathematical literacy abilities of these students through the lens of VARK learning styles and to identify effective strategies for enhancing their mathematical literacy based on their predominant learning style. To achieve this, the study is guided by two research questions: (1) What are the characteristics of students' mathematical literacy skills according to VARK learning styles? (2) What instructional strategies can teachers employ to enhance students' mathematical literacy skills, considering their learning styles?

Method

This study employs a descriptive qualitative approach to examine the mathematical literacy skills of junior high school students in terms of their learning styles. This approach was chosen because it allows researchers to gain an in-depth and detailed understanding of students' perceptions of their mathematics literacy skills in the context of their learning styles. Through this approach, researchers can elucidate the factors influencing students' mathematical literacy achievement and gain insight into the dynamics of the learning process. Additionally, the findings are utilized to propose instructional strategies to enhance students' mathematical literacy, tailored to align with each student's learning style.

This research was conducted on students in grade VIII of junior high school with informants selected using purposive sampling method. A total of five informants were selected from a total of 23 students in one class. The selection of informants is based on the criteria of the variation of learning style types that appear including A (Auditory), R (Read/Write), K (Kinesthetic), ARK (Auditory-Read/Write-Kinesthetic), and VRK (Visual-Read/Write-Kinesthetic); problem solving results; and their communication skills. This selection was made to ensure a diverse representation of various types of learning styles, so that the analysis can be more comprehensive and in-depth.

The main instruments used in this study included mathematical literacy problem-solving tasks, learning style measurement questionnaires and semi-structured interview guides. The mathematical literacy problem-solving task consisted of three problems that were validated by three experts and have met valid and reliable. This task was developed using mathematical literacy indicators including mathematical communication skills, mathematical modeling, representation, and problem solving. Questionnaires were used to

get an overview of students' learning style types. Meanwhile, semi-structured interviews were conducted to explore the characteristics of students' mathematical literacy skills based on differences in cognitive styles.

The research procedure included the following stages. First, students were given a math literacy problem solving task for 30 minutes. Second, the learning style measurement questionnaire was given to all students to be filled in based on their respective characters. Third, informants were selected as many as eight out of 23 participants by purposive sampling representing each type of learning style. The selection of informants considered students' answers and communication skills. Finally, unstructured interviews were conducted in-depth with the eight informants for 30-45 minutes, to reveal their problem-solving experiences on the mathematical literacy problems presented.

The data collected through problem-solving tasks and interviews, were analyzed using qualitative data analysis methods that included the stages of data presentation, data reduction, data interpretation, and conclusion [20]. At the data presentation stage, the results of mathematical literacy problem solving tasks and interviews, are grouped into categories that represent the type of student learning style. Data reduction is carried out by filtering relevant data according to the research objectives. In the data reduction section, students' mathematical literacy skills were categorized into good, lacking and sufficient levels, based on the criteria in Table 1 [21]. Furthermore, the interpretation of the data is conveyed through a narrative that explains the findings, analysis, and understanding of students' mathematical literacy problem-solving abilities based on their learning styles. In the last stage, conclusions were drawn by examining the relationship between categories and interpreting data based on theories about the characteristics of students' learning styles. To increase the validity of the research results, the researcher also applied data triangulation by comparing data from various collection sources. Through the data analysis process, the research is expected to provide insight into effective strategies in mathematics learning to support mathematical literacy skills by considering various types of student learning styles.

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Table 1 Criteria for Categorizing Mathematical Literacy Skills

Value Interval	Category
LM ≥ 86	Very good
71 ≤ LM ≤ 85	Good
51 ≤ LM ≤ 70	Fair
LM ≤ 50	Poor

Source: Author's processed data

Results and Discussion

The results of grouping students' learning styles based on the results of Questionnaire VARK edition 8.01, shown in Table 2. Table 2, shows that the results of the measurement of participants' learning styles in general, are divided into two groups, namely the unimodal and multimodal groups. The unimodal group consists of students who have only one type of learning style, while the multimodal group refers to students who have more than one type of learning style. From the measurement results, the multimodal group is a trimodal form, which is a combination of three learning styles.

Table 2 Results of Grouping Students' Learning Styles

Types of Learning Styles	Number of students	
	Unimodal	Multimodal
A	4	-
R	3	-
K	3	-
ARK	-	7
VRK	-	6
Total	23	

Source: Author's processed data

Furthermore, the results of the categorization of the mathematical literacy skills of the informants were grouped based on the categories of good, poor, and sufficient, as shown in Table 3.

Table 3. Mathematical Literacy Skills Categorization Results of Informants

Subject	Types of Learning Styles	Mathematical Literacy Skills		Category
		Unimodal	Multimodal	
S-01	A	77,78	-	Good
S-02	R	37,5	-	Poor
S-03	K	55,56	-	Fair
S-04	ARK	-	73,15	Good
S-05	VRK	-	77,78	Good

Source: Author's processed data

Based on the analysis presented in Table 3., two informants demonstrated good mathematical literacy skills. These informants were categorized under the auditory, ARK, and VRK types. One informant with a

read/write style was classified as a poor category. While the other informant, characterized by a kinesthetic style, fell into the fair category.

Students in the auditory type (S-01) show characteristics that have achieved good mathematical communication skills. However, it has not been consistent in implementing it. This finding is shown by S-01 in his answer as shown in Figure 1. Based on Figure 1, S-01 started her solution step by doing a memorization to communicate the problem. However, he was not consistent in writing it down, where in Figure 1 (a) he did not write down the information asked, while in Figure 1 (b), he wrote it down. In this finding, it was also seen that S-01 applied the form of mathematical representation with the type of mathematical symbols and expressions. This finding was supported by the results of the interview, where S-01 stated that *"I often hesitate in writing down the known and asked information when solving problems. Therefore, I only write it completely on problems that I understand".* Furthermore, S-01 also revealed reasons related to the use of symbol representations in the form of variables which were intended to make it easier for him to solve problems.

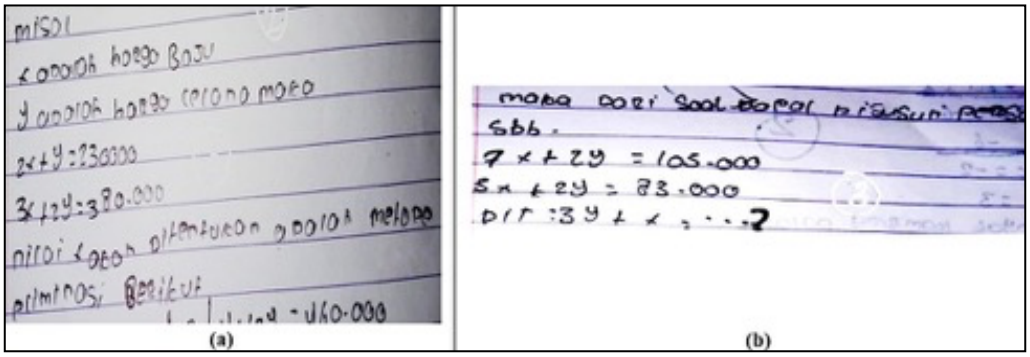

Figure 1. S-01's Answer in The Auditory Group

Figure 1 also shows S-01's proficiency in constructing mathematical models when solving a problem in mathematics. This ability can be seen in S-01's answer when writing a mathematical model in the form of $2x + y = 230000$ and $3x + 2y = 380000$ in Figure 1 (a), or in the form of $7x + 2y = 103000$ and $3x + 2y = 83000$ in Figure 1 (b). Furthermore, in the aspect of problem-solving ability, S-01 has shown good performance. This ability can be seen in one of his answer examples shown in Figure 2.

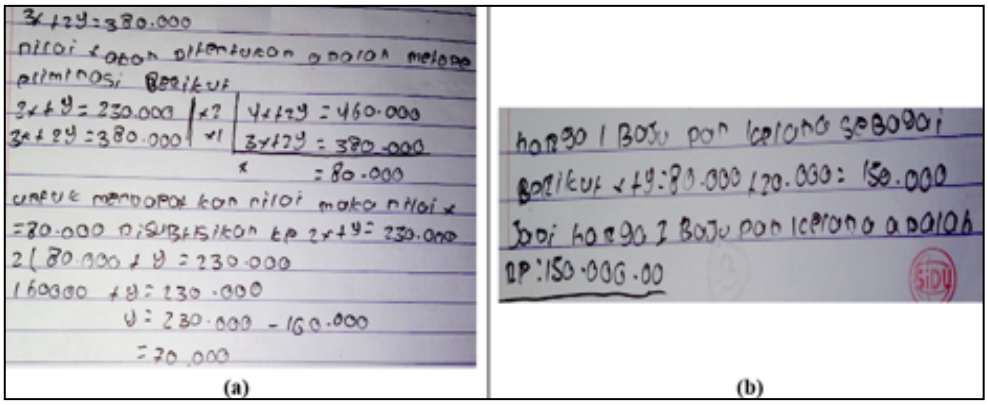

Figure 2. S-01's Answer in The Auditory Group

In Figure 2, S-01 showed good problem-solving skills. He was able to solve the given problem correctly until he found the solution. He also completed his answer by writing a conclusion at the end of his solution.

Read/write type students (S-02) have the characteristic of not being able to communicate mathematically well. This is demonstrated by S-02 in its answer as shown in Figure 3. In Figure 3 (a), S-02 showed her limitation in communicating the problem mathematically. He tried to express the problem information in the form of mathematical expressions, but was not precise in writing them down so that the statements made did not form a mathematical equation. Whereas in Figure 3 (b), S-02 was able to write the equation correctly in the known information part but was not able to state the related information asked. This finding also shows that S-02 was able to construct a mathematical model although not consistently. In the case of Figure 3 (a), S-02 was unable to write the mathematical model correctly in the form of an equation, whereas in Figure 3 (b), he was able to write it in the form of an equation, namely $7x + 2y = 105.000$ and $5x + 2y = 83.000$.

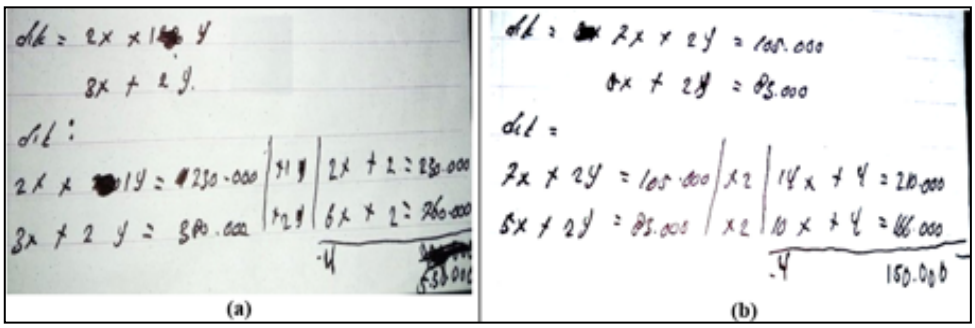

Figure 3. S-02's Answer in The Read/Write Group

In the aspect of using mathematical representation, S-02 shows its limitations by using only two forms, namely symbols and mathematical expressions. Furthermore, in terms of problem-solving ability, S-02 shows the limitations it faces. S-02 made an error in the implementation of the

elimination method. He performs a problem-solving process to eliminate one of the variables but is wrong in multiplying the equation by a certain number to equalize the coefficients of a variable. He was also unable to solve the problem until he found the requested answer.

Kinesthetic type students (S-03) have the characteristic of not being able to communicate mathematically well. This finding is shown by S-03 in its answer as shown in Figure 4.

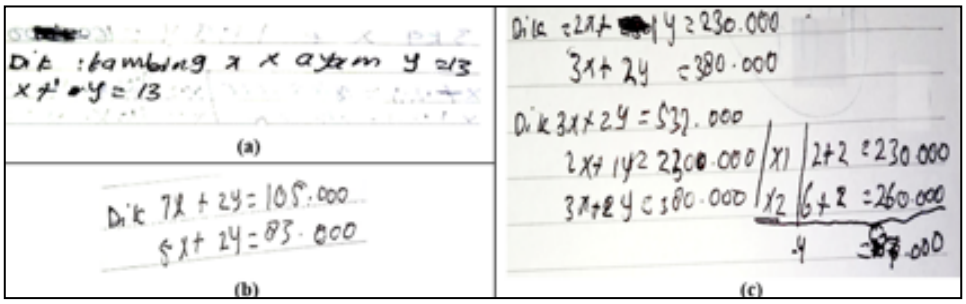

Figure 4. S-03's Answer in The Kinesthetic Group

Figure 4 shows the effort S-03 made to communicate the problem she faced. He tried to identify the information contained in the problem by writing down the known data. However, her way of communicating was still limited, and did not describe the whole information presented in the problem. She wrote "$goat\ x\ \times\ chicken\ y = 13$", then continued with the expression "$x + y = 13$". Based on the results of the interview, he stated that he did not understand how to solve the problem presented, so he only answered according to what he believed.

In the aspect of the ability to develop mathematical models, S-03 has shown good efforts even though it is not consistent. This finding can be seen in Figure 4 (a) and Figure 4 (b). Furthermore, in the aspect of using mathematical representation, S-03 has shown the initial ability of representation in the form of mathematical symbols and expressions. Meanwhile, in the aspect of problem-solving ability, S-03 showed a big limitation. In Figure 4 (c), S-03 did the problem-solving process using the elimination method. At this stage, he showed an error in the process of equalizing the coefficient of one of the variables from the mathematical equation. He eliminated the variable y, but during the coefficient equalization process, he multiplied equation one by "1" and equation two by "2". This resulted in the coefficient of variable y having a larger distance. However, at a later stage, she wrote the coefficient of the multiplication result for variable y had the same value of 2, which should have been 1 and 4. In addition, she omitted the variable in the solution step, which resulted in confusion about the answer. Based on these findings, S-03 confirmed her answer by stating *"I forgot how to solve this problem sir, so I tried to remember and tried to solve it according to what came to my mind"*.

ARK type students (S-04) have the characteristic of being able to communicate mathematically but are not consistent. Meanwhile, in the aspect of compiling mathematical models and the use of mathematical representations, he has done well. These findings are shown by S-04 in his answer as shown in Figure 5.

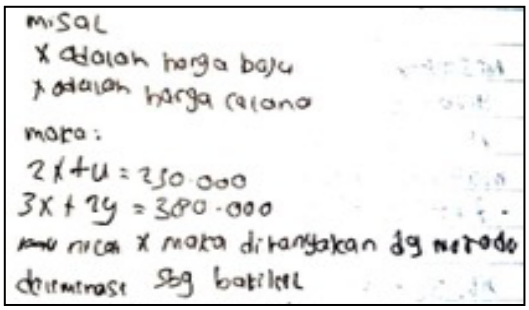

Figure 5. S-04's Answer in The ARK Group

In Figure 5, it appears that S-04 performs mathematical communication to explain the problem it faces by writing down the known information and the solution strategy to be used. He also showed proficiency in compiling mathematical models that began with the reasoning of variables, then continued with the statement of mathematical relationships in the form of equations. These findings also indicate that S-04 has good mathematical representation capabilities in the form of symbols, mathematical expressions, and verbal.

In terms of problem solving, the S-04 also shows that it has good capabilities. These findings can be seen in other answers as shown in Figure 6.

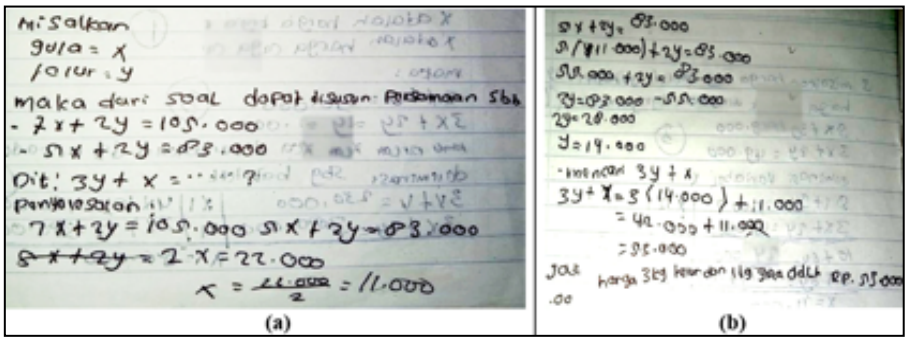

Figure 6. S-04's Answer in The ARK Group

In Figure 6, S-04 showed problem-solving proficiency through her solution steps. After the process of identifying information, she conducted the problem-solving strategy in a well-structured manner. At first, she used the elimination method to find the value of the x variable, then continued with the substitution method to find the value of the y variable. Next, she performed the final solution process that led to the goal of the problem, namely, determining the price of "3" kilograms of eggs and "1" kilogram of sugar. In addition, it was also seen that S-04 concluded her answer.

VRK type students (S-05) have the characteristics of being able to fulfill all indicators of mathematical literacy skills. However, there were some writing errors in the problem-solving stages. This finding was shown by S-05 in her answer as shown in Figure 7.

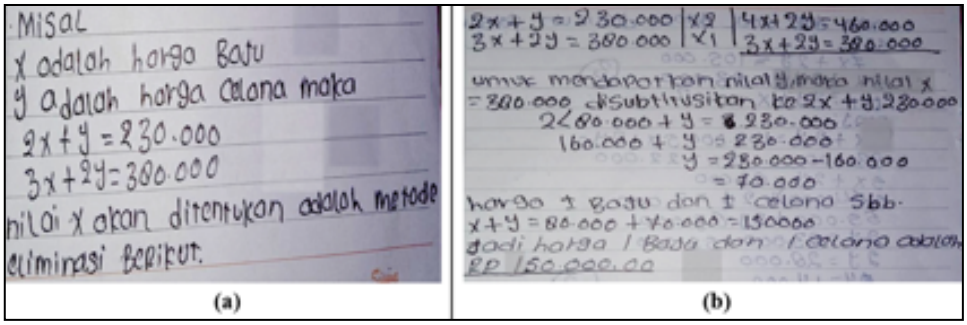

Figure 7. S-05's Answer in The VRK Group

Figure 7 shows that S-05 had a good ability to communicate the mathematical problems she faced. She started the problem-solving stage by explaining the problem information and the solution stages in a structured manner. He also showed proficiency in constructing mathematical models. In addition, S-05 showed the use of several forms of mathematical representations including symbols, mathematical expressions, and verbal.

Furthermore, regarding his problem-solving skills, he made several writing mistakes at his stages. She wrote "*to get the value of y, then the value of* $x = 380{,}000$*, substituted into* $2x + y$ $230{,}000$*".* In this part, she wrote the wrong x value which should be 80,000. Furthermore, he also did not give the "=" sign in the equation $2x + y = 230{,}000$. The next mistake was in the part "$2 < 80{,}000 + y = 230{,}000$", which should have been written "$2(80{,}000) + y = 230{,}000$". The characteristics of subjects' mathematical literacy skills based on their learning styles in general are shown in Table 4.

Table 4. Summary of Characteristics of Subjects' Mathematical Literacy Skills Based on Learning Style

Mathematical Literacy Indicators	Student characteristics				
	S-01 (A)	S-02 (R/W)	S-03 (K)	S-04 (ARK)	S-05 (VRK)
Mathematical Communication	Capable but inconsistent	Capable but not yet proficient	Not capable	Capable but inconsistent	Capable but not yet proficient
Developing Mathematical Models	Capable	Capable but inconsistent	Capable but inconsistent	Capable	Capable
Representation	Symbolic, mathematical expressions, and verbal	Symbolic and mathematical expressions	Symbolic and mathematical expressions	Symbolic, mathematical expressions, and verbal	Symbolic, mathematical expressions, and verbal
Problem-solving	Capable	Not capable	Not capable	Capable	Capable

Source: Author's processed data

The findings from this study highlight the significant impact of students' learning styles on their mathematical literacy, with distinct differences observed between unimodal and multimodal learners. This supports the existing body of literature, which stresses the importance of tailoring educational practices to individual learning preferences to enhance learning outcomes [22]. In particular, the results underscore how accommodating different learning styles can lead to improved engagement, deeper understanding, and better academic performance in mathematics. Given these findings, educators need to recognize and address these variations to promote effective teaching and learning.

Auditory learners, who excel in processing verbal information, demonstrated a notable strength in mathematical communication and problem-solving when verbal instruction was aligned with their learning preferences. This aligns with previous studies, such as Fernanda et al., which found that auditory learners outperform visual and kinesthetic learners in mathematical literacy tasks [23]. For these students, verbal explanations, discussions, and spoken symbols can significantly enhance their problem-solving skills. To optimize the learning experience for auditory learners, educators should focus on verbal instruction, incorporate opportunities for oral reasoning, and engage students in discussions that reinforce mathematical concepts. Teachers can support the development of critical mathematical literacy skills in this group by aligning teaching methods with their auditory strengths.

Conversely, read/write learners encountered difficulties in mathematical communication and problem-solving primarily due to their preference for written materials and symbolic representations. This finding emphasizes the importance of adapting instruction to include more written resources, such as detailed reading materials and note-taking opportunities. Research by Labuem highlights the value of personalized learning strategies for students who rely on written learning modes [24]. For read/write learners, providing opportunities to engage with written explanations, worksheets, and practice problems can help strengthen their mathematical literacy. Educators

[22] Shuvo Kumar Mallik and M Abeedur Rahman, 'An Analysis of Business Students Learning Styles to Improve the Effectiveness of Teaching Methods', *International Journal of Science and Research Archive* 13, no. 2 (30 November 2024): 1121–31, https://doi.org/10.30574/ijsra.2024.13.2.2224; Ristayuli Waruwu, 'The Relationship Between Learning Styles and Understanding Mathematical Concepts in Quadratic Functions', *Afore : Jurnal Pendidikan Matematika* 3, no. 2 (30 October 2024): 108–19, https://doi.org/10.57094/afore.v3i2.2319.

[23] Fernanda, Shodikin, and Susanah, 'Mathematics Literacy of Middle School Students with Socio-Cultural Context Viewed from Learning Style'.

[24] Susana Labuem, 'An Analysis of Mathematical Problem Solving Process Based on Learning Style', *Sora Journal of Mathematics Education* 5, no. 1 (31 May 2024): 53–64, https://doi.org/10.30598/sora.5.1.53-62.

must recognize these learners' preferences and incorporate strategies that support their need for written engagement to facilitate their mathematical understanding.

Kinesthetic learners also face challenges when exposed to traditional teaching methods, particularly in mathematical communication and problem-solving. This finding aligns with previous research, such as Rahim et al., which found that kinesthetic learners often struggle with conventional approaches [25]. These students tend to thrive when learning through physical activity, hands-on experiences, and real-world applications. To improve their mathematical literacy, educators should integrate kinesthetic activities, such as project-based learning, simulations, and experiments, that allow learners to manipulate objects and explore mathematical concepts through action physically. The research of Khatri and Khanal supports the notion that kinesthetic learners benefit from an experiential learning approach, which can be extended to mathematics instruction to enhance their conceptual understanding [26].

Multimodal learners, who combine multiple learning styles, such as ARK, demonstrated strong problem-solving abilities by drawing from various learning strategies. These learners benefit from integrating visual, auditory, and kinesthetic methods, allowing them to approach problems from different angles and employ diverse problem-solving strategies. This observation aligns with Rivai et al., who noted that multimodal learners exhibit enhanced problem-solving skills due to their ability to blend different learning styles [27]. However, VRK multimodal learners struggled with the accuracy of their calculations despite meeting other indicators of mathematical literacy. This finding contrasts with previous studies, such as Sholihah and Aini, which suggested that visual and kinesthetic learners, when integrated into multimodal learning, typically perform systematically and effectively in mathematical reasoning tasks [28]. These discrepancies highlight the complexity of multimodal learners' needs and further emphasize the importance of

[25] Rahim et al., 'Gaya Belajar Yang Berpengaruh Terhadap Kemampuan Literasi Matematika'.

[26] Tilak Bahadur Khatri and Bishnu Khanal, 'Mathematics Learning Style and Achievement of Secondary Level Students', *Journal of Musikot Campus* 2, no. 1 (17 October 2024): 234–53, https://doi.org/10.3126/jmc.v2i1.70847.

[27] Rivai et al., 'Students' Mathematical Literacy in Solving PISA Problems Observed by Learning Styles'.

[28] Nadirotus Sholihah and Afifah Nur Aini, 'Students' Mathematical Reasoning Ability with Visual, Auditorial and Kinesthetic Learning Styles in Solving Hots Problems', *Journal Focus Action of Research Mathematic (Factor M)* 6, no. 1 (28 June 2023): 49–66, https://doi.org/10.30762/factor_m.v6i1.1108.

flexible, adaptive teaching strategies that account for the diverse learning preferences within this group [29].

The findings of this study reinforce the importance of understanding and implementing learning strategies that align with students' learning styles to enhance their mathematical literacy. The VARK model provides a valuable framework for educators to develop more effective and tailored teaching strategies that cater to the unique preferences of individual learners. By considering these preferences, educators can create a learning environment that fosters deeper understanding and improved performance in mathematics instead of a one-size-fits-all approach that may overlook individual strengths.

The results also highlight the need for teaching methods to be adapted to students' learning preferences to improve their mathematical literacy. According to Mallik and Rahman, active learning methods benefit students who prefer an interactive approach [30]. Meanwhile passive methods are more suited for learners who prefer to engage through observation or reading. By adopting personalized learning strategies, educators can enhance students' problem-solving processes in mathematics [31]. Teachers can improve performance in arithmetic, algebra, and geometry by recognizing and adapting to the different learning styles within the classroom [32]. This approach ensures that all students, regardless of their learning style, can achieve optimal learning outcomes in mathematics

In practical terms, the implications of these findings are significant for mathematics education. For auditory learners, incorporating more verbal instruction, discussions, and oral explanations can help strengthen their mathematical reasoning and problem-solving abilities. As Fernanda et al. suggest, auditory learners benefit from interactive verbal exchanges that allow them to process and communicate mathematical concepts more effectively [33]. For read/write learners, strategies that involve in-depth reading materials, written explanations, and opportunities for notetaking are essential to support their learning. Educators can help these learners strengthen their problem-solving abilities by emphasizing written communication in the mathematics

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[29] Najrul Jimatul Rizki et al., 'Implementasi Model Vark Dalam Penguasaan Kelas Untuk Meningkatkan Prestasi Siswa', *RISOMA : Jurnal Riset Sosial Humaniora Dan Pendidikan* 2, no. 1 (12 February 2024): 71–84, https://doi.org/10.62383/risoma.v2i1.48.

[30] Shuvo Kumar Mallik and M Abeedur Rahman, 'An Analysis of Business Students Learning Styles to Improve the Effectiveness of Teaching Methods'.

[31] Labuem, 'An Analysis of Mathematical Problem Solving Process Based on Learning Style'.

[32] Khatri and Khanal, 'Mathematics Learning Style and Achievement of Secondary Level Students'.

[33] Fernanda, Shodikin, and Susanah, 'Mathematics Literacy of Middle School Students with Socio-Cultural Context Viewed from Learning Style'.

classroom [34]. Additionally, kinesthetic learners can benefit from an activity-based learning environment incorporating hands-on tasks, projects, and real-world applications to deepen their understanding of mathematical concepts. As Rivai et al. noted, kinesthetic learners excel in experiential learning, and such approaches should be embraced in mathematics education to cater to their needs [35].

Finally, for multimodal learners, creating a flexible learning environment that incorporates visual, auditory, and kinesthetic methods is crucial to allow students to draw connections between mathematical concepts and real-world situations [36]. By providing diverse learning materials and approaches, educators can better support multimodal learners in developing their mathematical literacy skills and meeting all indicators of mathematical reasoning [37]. Such strategies are essential in promoting inclusive education and improving mathematical literacy for all students.

Conclusion

This study investigated the effect of different learning styles on eighth grade students' mathematical literacy skills using the VARK model, which includes Visual, Auditory, Read/Write and Kinesthetic styles. The results showed that learning styles significantly affected students' ability to communicate mathematically, construct mathematical models, represent mathematical concepts and solve problems. Auditory learners show prominent proficiency in mathematical communication and problem solving when teaching methods are aligned with their verbal strengths. In contrast, read/write and kinesthetics learners experienced difficulties, indicating the need for teaching strategies that emphasize written materials, the importance of hands-on practice and opportunities for reflection.

Multimodal learners, particularly those with a combination of auditory, read/write and kinesthetic styles, excel in problem solving by integrating different learning approaches. These students effectively use diagrams and symbols to articulate mathematical concepts, which highlights the advantages of a flexible learning approach. However, VRK learners, despite meeting the indicators of mathematical literacy skills, faced challenges with calculation

[34] Labuem, 'An Analysis of Mathematical Problem Solving Process Based on Learning Style'.

[35] Rivai et al., 'Students' Mathematical Literacy in Solving PISA Problems Observed by Learning Styles'.

[36] Nadiva Dwi Anggani et al., 'Kemampuan Komunikasi Matematis Siswa SMP Ditinjau Dari Gaya Belajar', *GAUSS: Jurnal Pendidikan Matematika* 7, no. 1 (10 June 2024): 33–42, https://doi.org/10.30656/gauss.v7i1.7952.

[37] Sholihah and Aini, 'Students' Mathematical Reasoning Ability with Visual, Auditorial and Kinesthetic Learning Styles in Solving Hots Problems'.

errors, indicating the need for special support such as practice with reflection to overcome these weaknesses.

The implications of this study encourage teachers to align their teaching methods with students' learning styles to improve students' mathematical literacy skills. The implementation of VARK model-based learning strategies can support students' mathematical literacy development more effectively. This includes developing teaching materials and teaching methods that accommodate the unique needs of each learning style. Personalized learning strategies based on an understanding of students' learning styles can improve the problem-solving process in mathematics and meet the various needs of students. This approach not only supports academic achievement but also prepares students to apply math skills in real-world scenarios.

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