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ANALYSIS OF STUDENTS' ABILITY TO MAKE MATHEMATICAL CONNECTIONS IN SOLVING STORY PROBLEMS INVOLVING INTEGER OPERATIONS AT SMPN 19 PALU FROM THE PERSPECTIVE OF LEARNING STYLES

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Abstract

This study aims to analyze students' mathematical connection skills in solving word problems involving integer operations based on visual, auditory, and kinesthetic learning styles. This study employs a qualitative descriptive approach involving three seventh-grade students selected through purposive sampling at SMP Negeri 19 Palu. Data collection techniques included a learning style questionnaire, a written test, and interviews, which were analyzed using the Miles and Huberman model. The results indicate that all participants met the indicators of mathematical connection ability; however, differences were observed in the depth and methods of representing these connections. Students with a kinesthetic learning style demonstrated a stronger ability to relate mathematical concepts to real-life contexts. Auditory learners were able to connect mathematical concepts with other disciplines, while visual learners tended to focus on calculation procedures with limited contextual relevance. These findings indicate that learning styles influence how students construct and represent mathematical connections

Keywords: Mathematical Connections, Word Problems, Learning Styles

Abstrak

Penelitian ini bertujuan untuk menganalisis kemampuan koneksi matematis siswa dalam menyelesaikan soal cerita operasi bilangan bulat berdasarkan gaya belajar visual, auditorial, dan kinestetik. Penelitian ini menggunakan pendekatan deskriptif kualitatif dengan melibatkan tiga siswa kelas VIIA yang dipilih secara purposive di SMP Negeri 19 Palu. Teknik pengumpulan data meliputi angket gaya belajar, tes tertulis, dan wawancara, yang dianalisis menggunakan model Miles dan Huberman.Hasil penelitian menunjukkan bahwa seluruh subjek memenuhi indikator kemampuan koneksi matematis, namun terdapat perbedaan pada kedalaman dan cara representasi koneksi tersebut. Siswa dengan gaya belajar kinestetik menunjukkan kemampuan yang lebih kuat dalam mengaitkan konsep matematika dengan konteks kehidupan nyata. Siswa auditorial mampu menghubungkan konsep matematika dengan disiplin ilmu lain, sedangkan siswa visual cenderung berfokus pada prosedur perhitungan dengan keterkaitan konteks yang masih terbatas.Temuan ini menunjukkan bahwa gaya belajar memengaruhi cara siswa dalam membangun dan merepresentasikan koneksi Matematis

Kata kunci: Koneksi Matematis, Soal Cerita, Gaya Belajar

INTRODUCTION

In the learning process at school, mathematics is an important subject, but many students still have difficulty solving problems, especially word problems. Word problems are an important tool for measuring student understanding because they require the ability to relate the context of the problem to relevant mathematical concepts. One of the skills that plays an

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important role in solving word problems is mathematical connection skills. This ability allows students to connect mathematical concepts with everyday life, other subjects, and problem-solving strategies, making learning more meaningful (Julaeha et al., 2020). The NCTM also emphasizes that mathematics learning should encourage students to build meaningful connections between mathematical ideas (Alfisyahra et al., 2021).

However, in reality, students' mathematical connection skills are still relatively low. This can be seen from the difficulty students have in converting contextual problems into appropriate mathematical models or sentences, especially in story problems related to everyday life (Hidayati & Jahring, 2021). One of the factors that influence this condition is the difference in students' learning styles.

Visual, auditory, and kinesthetic learning styles influence how students receive and process information, thereby impacting their ability to connect mathematical concepts with previous experiences (Whyuni et al., 2023). Several studies show that learning styles are closely related to students' mathematical connection abilities (Syabina et al., 2024). Therefore, the analysis of mathematical connection abilities based on learning styles can be done through solving story problems (Nasution & Elvira, 2022).

This study focused on integer operation story problems because this material is a basic concept that is often used in everyday life and is the foundation for further mathematics material (Sepriyati & Setianingrum, 2018). Based on the results of interviews with seventh-grade mathematics teachers at SMP Negeri 19 Palu, it is known that students still have difficulty solving integer operation story problems and there is no clear picture of students' mathematical connection abilities in terms of their learning styles.

Based on the above description, this study aims to analyze the mathematical connection abilities of seventh-grade students in solving integer operation story problems in terms of visual, auditory, and kinesthetic learning styles at SMP Negeri 19 Palu.

METHODS

This study employs a descriptive method with a qualitative approach. Qualitative descriptive research aims to generate data in the form of written and spoken words to provide an in-depth understanding of the phenomenon under study. Therefore, this study focuses on

describing and analyzing students' mathematical connection skills in solving word problems involving integer operations, as viewed through the lens of learning styles.

This study was conducted at SMP Negeri 19 Palu during the odd semester of the 2025/2026 academic year.

The research subjects consisted of three seventh-grade students from Class VII A, each representing visual, auditory, and kinesthetic learning styles. Subject selection was conducted using purposive sampling based on the results of a learning style questionnaire developed by Yaumi (2017). Students with the highest scores in each learning style category were selected as research subjects.

The use of three subjects in this study aims to gain a deep understanding of the characteristics of mathematical connection skills within each learning style. This aligns with the qualitative research approach, which emphasizes depth of analysis over generalization of results.

Data collection techniques in this study included a learning style questionnaire, a written test, and interviews. The written test consisted of word problems involving integer operations designed to measure students' mathematical connection abilities based on predetermined indicators.

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The research instruments were first validated by two experts in mathematics education. The validation process included an assessment of content appropriateness, linguistic clarity, and the alignment of test items with indicators of mathematical connection skills. Based on the validation results, revisions were made to the instruments before they were used in the study.

After the students completed the written test, semi-structured interviews were conducted to explore in greater depth the students' thought processes in solving the problems. The interviews were recorded to ensure data accuracy and facilitate analysis.

Data validity was tested using the member check technique, which involves reconfirming the findings with the research subjects to ensure consistency between the obtained data and the subjects' intended meanings (Sugiyono, 2020).

Data analysis was conducted using the Miles and Huberman model (Miles et al., 2014), which comprises three stages:

1. Data condensation, which involves selecting, focusing on, and simplifying raw data.
2. Data presentation, which involves organizing data into narratives, tables, or interview excerpts to ensure clarity.
3. Drawing conclusions, which is the process of interpreting data to derive meaning from the research findings.

In addition, a cross-case analysis was conducted to compare the subjects' mathematical reasoning abilities based on their visual, auditory, and kinesthetic learning styles, thereby

providing a more in-depth understanding of the differences and similarities among the subjects.

The indicators used in this study refer to those proposed by (Maulida et al., 2019), as presented in Table 1.

Table 1. Mathematical Connection Ability Indicators

No	Indicator	Description
1	Connections between mathematical topics	Students can recognize connections between mathematical concepts in mathematics and use these connections between concepts.
2	Recognizing and applying mathematics in contexts outside of mathematics	Students can recognize concepts from other disciplines and use those concepts to solve problems in mathematics.
3	Connections between mathematical concepts and the real world or everyday life	Students can recognize and solve mathematical problems related to everyday life.

RESULTS AND DISCUSSION

In this study, the research subjects were seventh-grade students in Class VII A at SMP Negeri 19 Palu. To obtain the research subjects, the researcher grouped the students based on their learning styles, namely visual, auditory, kinesthetic, and visual-auditory learning styles. The learning styles were grouped by administering a learning style questionnaire to the students in Class VII A on Monday, December 1, 2025. Based on the results of the learning style grouping of 28 students, the data obtained is presented in Table 2.

Table 2 Results of Learning Style Tests for Grade VII A Students

No	Learning Style	Number of Students
1	Visual	20
2	Auditory	3
3	Kinesthetic	2
4	Auditory-Visual	3

Table 2 shows that from 28 students in class VII A of SMP Negeri 19 Palu, data was obtained that 20 students had a visual learning style, 3 students had an auditory learning

style, 2 students had a kinesthetic learning style, and 3 students had a visual-auditory learning style. However, this study only focused on three learning styles, namely visual, auditory, and kinesthetic learning styles. The research subjects were selected based on the students who obtained the highest scores in each of these learning styles. Furthermore, the researcher discussed with the mathematics teacher to obtain consideration in selecting students from each learning style. Data on subjects with visual, auditory, and kinesthetic learning styles are presented in Table 3.

Table 3. Research Subjects

No	Subject Code	Learning Style
1	KA	Kinesthetic
2	YA	Visual
3	VM	Auditory

To facilitate understanding of the analyzed data, written test data and interview results were assigned specific codes. The code KA was used for students with a kinesthetic learning style, the code YA for students with a visual learning style, and the code VM for students with an auditory learning style. Furthermore, three digits were used to indicate the line of conversation in the interview transcript. The code PN is used to indicate the researcher in the interview transcript.

Analysis of KA Subject Data in Solving Integer Operation Story Problems

1. Analysis of KA Subject Data on the Indicator of Restating Connections between Topics in Integer Operation Story Problems

The results of KA students' written tests on the indicator of mathematical connection skills in restating connections between mathematical topics are presented in Figure 1 below.

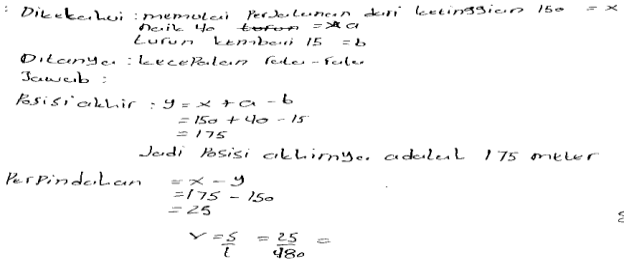

Figure 1. Subject KA answers on the indicator of restating connections between topics Mathematics

During the interview stage, the subject KA restated the connections between the mathematics topics that had been learned through verbal explanations during the interview and presented in Table 4.

Table 4. Restating connections between mathematical topics

	Dialogue
PNS-105	When you see the data going up and down, what mathematical concept immediately comes to mind?
KAS-106	Addition and subtraction, because going up is adding and going down is subtracting
PNS-119	How do you determine the displacement value in this question?
KAS-120	I take the difference between the increase and decrease, which is 40 minus 15, so 25 meters

Based on the results of tests and interviews, the kinesthetic learner (KA) was able to connect several mathematical concepts, such as integer operations, displacement, and average speed. However, the strength of KA's connections lies not only in the ability to identify concepts, but in the way they build understanding through the imagination of movement, such as visualizing the conditions of going up and down. This indicates that the kinesthetic learning style helps students build mathematical connections through concrete experiences, making the concepts more meaningful. Compared to other subjects, KA subjects demonstrated a tendency toward more contextual connections, particularly in relating mathematical concepts to real-life situations.This finding aligns with the view that connections between concepts can deepen students' understanding (Apipah & Kartono, 2017).

2. Analysis of KA Subject Data on the Indicator of Restating Mathematical Connections in Non-Mathematical Contexts of Integer Operations Story Problems

The results of the KA students' written tests on the indicator of mathematical connection skills in Restating Mathematical Connections in Non-Mathematical Contexts are presented in Figure 2 below.

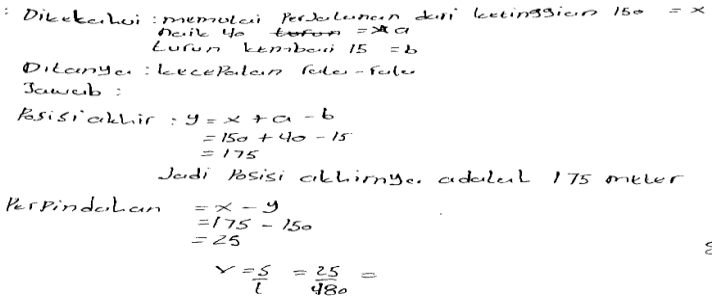

Figure 2. Subjects' responses to the indicator of restating mathematical connections in contexts outside of mathematics

During the interview stage, KA subjects restated mathematical connections in contexts outside of mathematics through verbal explanations during the interview, which are presented in Table 5.

Table 5. KA Reiterates mathematical connections in contexts outside of mathematics

	Dialogue
PNS-127	Have you ever studied the concept of speed before?
KAS-128	Yes, when I studied physics.
PNS-129	What similarities are there between this question and what you learned in physics?
KAS-130	They are both about displacement and speed.
PNS-131	How does mathematics play a role in solving physics problems like this?They are both about displacement and speed.
KAS-132	Mathematics is used to calculate it; if you don't calculate it, you can't get the result.

Based on the interview results, KA is able to connect mathematical concepts with physical concepts, particularly regarding displacement and velocity. KA understands that displacement is calculated as the difference in position, while average velocity is calculated by dividing displacement by elapsed time. Furthermore, KA builds this understanding through the imagination of movement, such as visualizing the activity of going up and down, making the relationship between mathematical concepts and real-world situations easier to grasp. This indicates that a kinesthetic learning style supports the formation of mathematical connections through concrete experiences. Compared to other subjects, KA demonstrates a more explicit connection between mathematics and other disciplines, indicating a more contextual understanding. This finding aligns with the view that students with a kinesthetic

learning style tend to build understanding through direct experience and movement representations (Diva & Purwaningrum, 2022)

3. Analysis of KA Subject Data on Indicators shows a renewed connection between mathematical concepts and the real world or everyday life in the form of integer operation story problems.

The results of the KA students' written tests on the indicator of mathematical connection skills in the connection between mathematical concepts and the real world or everyday life are shown in Figure 3 below.

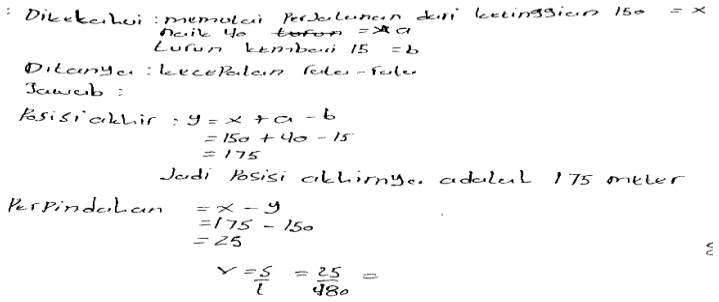

Figure 3. Subject KA answers to the indicator "Reiterating the connection between mathematical concepts and the real world or everyday life.

During the interview stage, KA Subjects restated mathematical connections in contexts outside of mathematics through verbal explanations during the interview, which are presented in Table 6.

Table 6. KA Reiterates the connection between mathematical concepts and the real world or everyday life

	Dialogue
PNS-135	Yes, because climbing a mountain is a real activity.
KAS-136	How did you imagine the climber's situation when working on the question?
PNS-137	I imagined the climber actually going up and down, so it was like moving up and down.
KAS-138	I imagined the climber actually going up and down, so it was like moving up and down.
PNS-139	Does that image help you with the calculations?
KAS-140	Yes, it makes it easier to understand why there are additions and subtractions.

Based on the interview results, KA is able to relate mathematical concepts to real-life situations, such as climbing activities that involve moving up and down. KA understands that these changes in position are related to addition and subtraction operations, and are used to determine displacement and velocity. Furthermore, KA builds understanding through the imagination of movement, namely by directly visualizing the activities of going up and down. This indicates that a kinesthetic learning style helps students connect mathematical concepts to everyday experiences in a more meaningful way. Compared to other subjects, KA demonstrates a stronger connection between mathematical concepts and real-life contexts, indicating a more contextual understanding. This finding aligns with the view that learning that links mathematical concepts to daily life can enhance students' understanding in a more meaningful way (Bernard & Senjayawati, 2019).

Analysis of subject YA's data in solving integer operation story problems.

1. Analysis of Subject Data YA on Indicators Reiterating connections between mathematical topics in story problems involving integer operations

The results of YA students' written tests on the indicator of mathematical connection skills in restating connections between mathematical topics are presented in Figure 4 below.

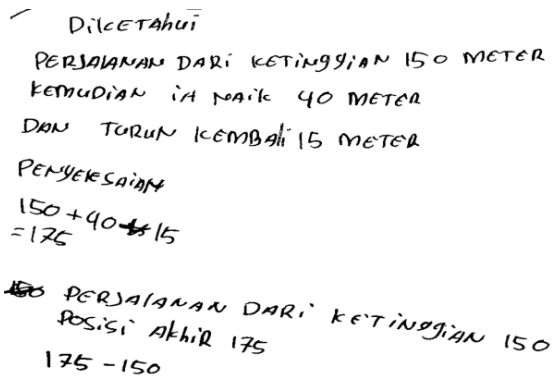

Figure 4. Subjects' YA responses to indicators of restating connections between topics Mathematics

During the interview stage, subject YA restated the connections between the mathematics topics that had been studied through verbal explanations during the interview and presented in Table 7.

Table 7. Restating connections between mathematical topics

Dialogue

PNS-111	From that question, is there a connection with other math topics?
YAS-112	Yes.
PNS-113	What topics are connected?
YAS-114	Positive and negative numbers.
PNS-115	What do you mean by positive and negative?
YAS-116	Positive means addition, negative means subtraction.
PNS-119	What mathematical subject do positive and negative numbers belong to?
YAS-120	Integer operations.

Based on the interview results, YA was able to relate the concepts of positive and negative numbers to addition and subtraction operations within the context of the problem. YA understood that a positive sign indicates addition, while a negative sign indicates subtraction in integer operations. This indicates that YA is able to establish connections between mathematical concepts procedurally through symbolic representations. However, the connections demonstrated are still limited to recognizing relationships between concepts without the development of more contextual meaning. Compared to kinesthetic learners (KA), the connections established by YA tend to focus more on symbols and rules, thus showing less deep relevance to real-world situations. These findings suggest that the visual learning style better supports understanding through symbolic representations in building mathematical connections (R et al., 2025).

2. Analysis of Subject YA Data on Indicators of restating mathematical connections in contexts outside of mathematics

The results of YA students' written tests on the indicator of mathematical connection skills in rephrasing mathematical connections in contexts outside of mathematics are presented in Figure 5 below.

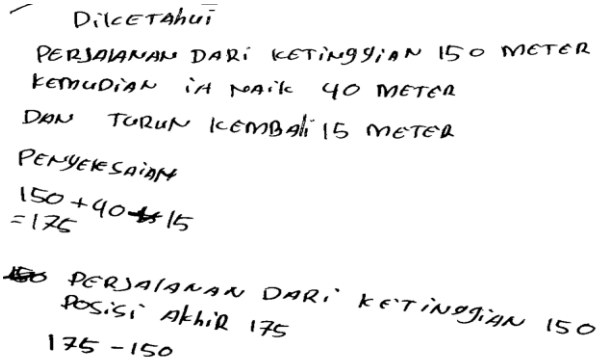

Figure 5. Subjects' YA responses to indicators of restating mathematical connections in contexts outside mathematics

During the interview stage, Subject YA restated the mathematical connection in a non-mathematical context through verbal explanations during the interview, which are presented in Table 8.

Table 8. KA Reiterates mathematical connections in contexts outside of Mathematics

	Dialogue
PNS-101	Try to retell the question you worked on in your own words.
YAS-102	The question tells the story of a climber who started his journey at an altitude of 150 meters above sea level, then climbed 40 meters and descended 15 meters, and was asked to determine his average speed of movement.
PNS-103	fter reading the question, what do you know from it?
YAS-104	He starts his journey from an altitude of 150 meters above sea level, then climbs another 40 meters, then descends 15 meters.
PNS-105	What is being asked in the question?
YAS-106	To determine the average displacement using s (displacement) and t (travel time).

Based on the interview results, YA was able to understand the problem situation and identify information related to the concepts of motion and time. However, on the answer sheet, YA proceeded directly to the calculations without explicitly demonstrating the connection between mathematical and physical concepts.This indicates that the connections established are still implicit and procedural. Compared to the kinesthetic learner (KA), YA demonstrated a weaker clear connection between mathematics and contexts outside of mathematics. This finding indicates that students' mathematical connection skills still need to be developed so that they focus not only on calculations but also on conceptual understanding (R et al., 2025)

3. Analysis of Subject Data YA On the indicator of restating the connection between mathematical concepts and the real world or everyday life in integer operation story problems.

YA student's written test results on the indicator of mathematical connection skills in connecting mathematical concepts and the real world or everyday life in Figure 6.

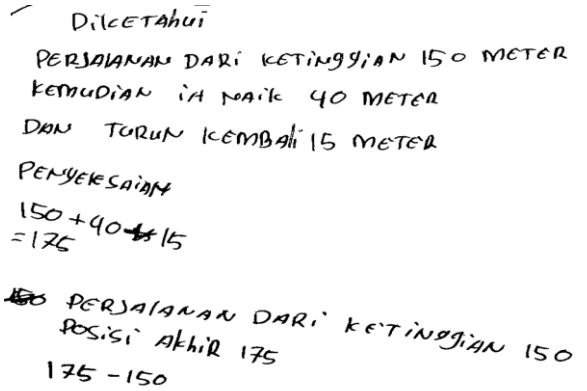

Figure 6. Subject YA answer to the indicator "Reiterating the connection between mathematical concepts and the real world or everyday life."

During the interview stage, KA Subjects restated mathematical connections in contexts outside of mathematics through verbal explanations during the interview, which are presented inTable 9.

Table 9. KA Reiterates the connection between mathematical concepts and the real world or everyday life

	Dialogue
PNS-101	Try to retell the question you worked on in your own words?
YAS-102	The question tells the story of a climber who started his journey at an altitude of 150 meters above sea level, then climbed 40 meters and descended 15 meters, and was asked to determine his average speed of movement.
PNS-103	After reading the question, what do you know from it?
YAS-104	He starts his journey from an altitude of 150 meters above sea level, then climbs another 40 meters, then descends 15 meters.

Based on the results of the written test and interview, YA is able to recognize and relate mathematical concepts to real-life contexts. This is evident in YA's ability to understand

problem situations and connect them to the concepts of positive and negative numbers. However, the connections established are still simple and do not yet demonstrate a deep understanding. Compared to the kinesthetic learner (KA), the connections demonstrated by YA tend to be limited to contextual understanding without further development of conceptual relationships. These findings suggest that while real-life contexts aid student understanding, mathematical connection skills still need to be developed to be more meaningful (Rafiepour & Faramarzpour, 2023).

Analysis of VM subject data in solving integer operation story problems.

1. Analysis of Subject Data VM on Indicators Reiterating connections between mathematical topics in story problems involving integer operations

The results of VM students' written tests on mathematical connection skills in restating connections between mathematical topics are presented in Figure 7 below.

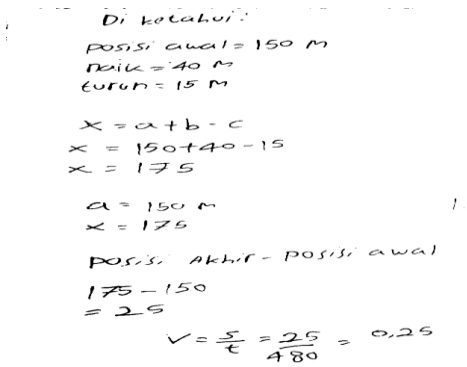

Figure 7. Subjects' responses on the indicator of restating connections between topics Mathematics

During the interview stage, subject YA restated the connections between the mathematics topics that had been studied through verbal explanations during the interview and presented in Table 10.

Table 10. Restating connections between mathematical topics

	Dialogue
PNS-101	How did you feel when you first saw this question?
VMS-102	At first I was a little confused, but after reading it several times I began to understand what was being asked.
PNS-103	What is known from the question?
VMS-104	A mountain climber starts the journey from an altitude of 150 meters above sea level, then climbs 40 meters and descends 15 meters. So I know there is a change in altitude that must be calculated before finding the speed.

PNS-105	What is being asked in the question?
VMS-106	The question asks to determine the speed using s (displacement) and t (time taken).

Based on the results of written tests and interviews, auditory learners (VM) were able to relate the concepts of positive and negative numbers to changes in height within the context of the problems. VM understood that addition is used when there is an increase, while subtraction is used when there is a decrease. However, the connections established still tend to be procedural in nature and do not yet demonstrate a deeper conceptual understanding. Compared to the kinesthetic learner (KA), VM relies more on verbal explanations when establishing mathematical connections. These findings suggest that the auditory learning style supports understanding through verbal explanations, although further development is needed to establish more conceptual connections (Rizki & Budiman, 2023)

2. Subject Data Analysis VM on Indicators states the mathematical connection in a non-mathematical context.

The results of VM students' written tests on the indicator of mathematical connection skills in rephrasing mathematical connections in contexts outside mathematics are presented in Figure 8 below.

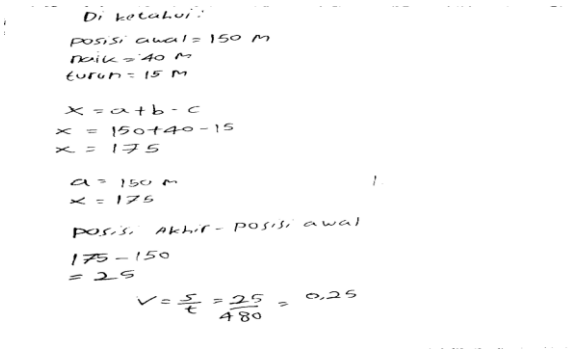

Figure 8. Subjects' responses on the indicator of restating mathematical connections in non-mathematical contexts

During the interview stage, Subject YA restated the mathematical connection in a non-mathematical context through verbal explanations during the interview, which are presented in Table 11.

Table 11. VM Reiterates mathematical connections in contexts outside of Mathematics

Dialogue	
PNS-101	How did you feel when you first saw this question?

VMS-102	At first I was a little confused, but after reading it several times I began to understand what was being asked.
PNS-103	What is known from the question?
VMS-104	A mountain climber starts the journey from an altitude of 150 meters above sea level, then climbs 40 meters and descends 15 meters. So I know there is a change in altitude that must be calculated before finding the speed.
PNS-105	What is being asked in the question?
VMS-106	The question asks to determine the speed using s (displacement) and t (time taken).

Based on the results of the tests and interviews, auditory learners (VM) were able to relate mathematical concepts to contexts outside of mathematics, such as physics. This was evident in their ability to understand situations involving going up and down and to relate them to the concepts of displacement and average speed. However, the connections established are still general in nature and do not yet demonstrate deep understanding. Compared to kinesthetic learners (KA), auditory learners (VM) place greater emphasis on verbal explanations when understanding the relationships between concepts. These findings suggest that the auditory learning style supports the process of making connections through verbal communication, although further reinforcement is needed in the conceptual aspect (Muflihah et al., 2019).

3. Analysis of Subject Data VM on Indicators shows a connection between mathematical concepts and the real world or everyday life in the form of integer operation stories.

YA student's written test results on the indicator of mathematical connection skills in connecting mathematical concepts and the real world or everyday life in Figure 9.

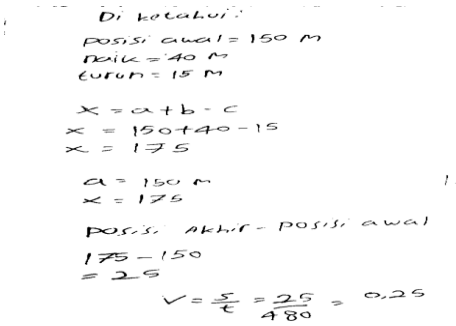

Figure 9. Subjects' responses on the indicator "Reiterating the connection between mathematical concepts and the real world or daily life.

During the interview stage, KA subjects restated mathematical connections in contexts outside of mathematics through verbal explanations during the interview, which are presented in Table 12.

Table 12. VM Reiterates the connection between mathematical concepts and the real world or everyday life.

	Dialogue
PNS-127	Does imagining the problem as a real-life situation help you understand it?
VMS-128	Yes, like imagining climbing stairs or a hill, so it's easier to understand how the movement works.
PNS-129	Can you relate this problem to other math topics?
VMS-130	Yes, namely positive and negative integers, as well as the concept of average speed
PNS-131	Can this question be related to other subjects or everyday life?
VMS-132	Yes, it can be related to physics, because there are concepts of displacement and average speed.

Based on the results of written tests and interviews, auditory learners (VM) were able to relate mathematical concepts to real-life contexts. This was evident in their ability to understand problem situations as real-world events, such as the act of going up and down However, the connections established are still simple and do not yet demonstrate deep understanding. Compared to kinesthetic learners (KA), VM learners rely more on verbal explanations to understand conceptual relationships. These findings suggest that real-world contexts aid student understanding but need to be supported by conceptual reinforcement to make mathematical connections more meaningful (Maryanasari & Zanthy, 2020).

CONCLUSION

Based on the research findings, students' mathematical connection abilities in solving word problems involving integer operations showed differences across learning styles. Kinesthetic learners (KA) demonstrated stronger connection abilities, particularly in linking mathematical concepts to real-world experiences through the imagination of movement. Auditory learners (VM) were able to build connections through verbal explanations and link mathematical concepts to other disciplines, although their approach tended to remain procedural. Meanwhile, visual learners (YA) place greater emphasis on symbolic

representations and procedures, yet their connection to real-world contexts has not yet developed optimally.

These findings indicate that mathematical connection skills depend not only on computational ability but also on how students construct meaning through their respective learning styles. These differences underscore the importance of considering learning style characteristics in mathematics instruction.

The implication of this study is the need for teachers to design instruction that accommodates various learning styles, such as using contextual activities for kinesthetic learners, discussions and verbal explanations for auditory learners, and visualizations and symbolic representations for visual learners. Thus, students' mathematical connection skills can develop more optimally and meaningfully.

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