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Students' Errors in Understanding Numeracy Problems: A Case Study of Kinesthetic Students

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ABSTRACT

Numeracy problems are predominantly presented in visual form so kinesthetic students tend to find it difficult to understand the problems given. This qualitative study intends to analyze the errors made by kinesthetic students in understanding the problems during solving numeracy problems. This research took place in private junior high school students in Malang city. Researchers used learning style test questionnaires, numeracy problem test results, and interview results to obtain data, which were then analyzed through data reduction, data presentation, and conclusion/verification. Based on the study's results, it was found that kinesthetic students made three types of errors in understanding the numeracy problems, namely 1) error in stating the information/data needed, 2) errors in stating what is asked from the problem, and 3) errors in interpreting information/data. These errors are caused by several things, including 1) students' lack of ability to interpret the reading, 2) students' lack of willingness to reread the problems presented, 3) the numeracy problems presented are complicated, i.e. presented with many numbers and objects, 4) students tend to rush to solve the problems so they do not do the reexamination process.

Keywords : kinesthetic; numeracy; problem-solving; errors.

INTRODUCTION

Numeracy is an essential skill that needs to be developed early on (Ali & Idris, 2013; Nicholas, 2014; Purnomo et al., 2022; Rakhmawati & Mustadi, 2022). Numeracy is defined as a person's ability to formulate, use, and interpret mathematical concepts in various contexts (Madyaratri & Prasetyo, 2019; Rakhmawati & Mustadi, 2022). These include conceptual mathematical reasoning, procedures, and the ability to describe, explain facts, and estimate a phenomenon (Madyaratri & Prasetyo, 2019; Rakhmawati & Mustadi, 2022). In line with this, numeracy is also related to the ability to apply number concepts and skills to use and perform counting operations, as well as the ability to interpret quantitative information in everyday life (Aishalya et al., 2021; Han et al., 2017; Assessment Center, 2020; Rakhmawati & Mustadi, 2022). With good numeracy skills, students are expected to be able to find solutions to problems that occur in everyday life (Annisavitri et al., 2020). Unfortunately, students' numeracy skills in Indonesia are still low.

Based on data from OECD 2023, only 18% of students were able to interpret and recognize the problems presented without direct instruction. This is in line with the results of Udil & Samo's research (2023) which states that students' low numeracy skills are caused by several factors, including difficulties in understanding numeracy problems, difficulties in applying, and difficulties in reasoning. In addition, the results of research by Rakhmawati & Mustadi (2022) show that students' low numeracy skills are caused by students' lack of ability to understand numeracy problems, students are not familiar with problems presented

in the form of stories and the stages of the problem solving process. Furthermore, Sa'dijah et al. (2023) stated that students' low numeracy skills were caused by the teacher's lack of ability to develop numeracy problems, as well as the lack of a learning environment that supports the meaningful learning process.

Numeracy problems are presented in the form of writing with several paragraphs containing new information related to a problem related to numeracy topics (Assessment Center, 2020). In addition, mathematical information in numeracy is usually presented in the form of graphs, charts, and tables (Han et al., 2017; Rakhmawati & Mustadi, 2022). In other words, mathematical information in numeracy problems is often presented in visual form, so it requires the ability to process visual information well in order to interpret numeracy problems appropriately. In fact, to understanding the problem given required an ability in processing the information. The way students understanding the problem are influenced by the learning styles.

In general, there are three learning style modalities, namely visual, auditory, and kinesthetic. Students with visual learning styles find it easier to receive and process information in visual form (pictures, graphs, tables, etc.), while students with auditory learning styles find it easier to receive and process information that is verbal (auditorial), and students with kinesthetic learning styles find it easier to process information that involves movement (kinesthetic) (DePorter & Hernacki, 2008; Rezaeinejad et al., 2015; Rini et al., 2020; Wahyuni, 2022). Trisnaningtyas & Khotimah's research (2022) found that kinesthetic students were able to mention the information contained in numeracy problems, but failed to carry out the relevant model/solution strategy so that the results and conclusions produced were irrelevant. In addition, the results of Wahyuni's research (2022) state that students with kinesthetic learning styles are not happy when asked to solve problems in the form of images. Therefore, kinesthetic students will experience obstacles in solving numeracy problems, especially in understanding the problems.

So far, no research has explored the errors and factors that cause errors made by kinesthetic students focusing in understanding the problems. In fact, this information is very important for both teachers and students, to support the learning and teaching process in the classroom. For teachers, the information obtained can be used as a reference to facilitate the student learning process according to the characteristics and uniqueness of the students.

RESEARCH METHODS

This research is a descriptive qualitative research with a case study approach that aims to describe the errors and factors that influence kinesthetic students in making mistakes in understanding the problem during the numeracy problem solving process. This case study was chosen, because 30-40% of students in Indonesia have a kinesthetic learning style, so researchers feel the need for strategies, models, methods, and assessments that can help teachers to facilitate student diversity during the learning process and can help kinesthetic students to improve their quality and learning outcomes.

Research Subjects

The subjects of this study were private junior high school students in Malang who have kinesthetic learning styles. The selection of research subjects was based on the results

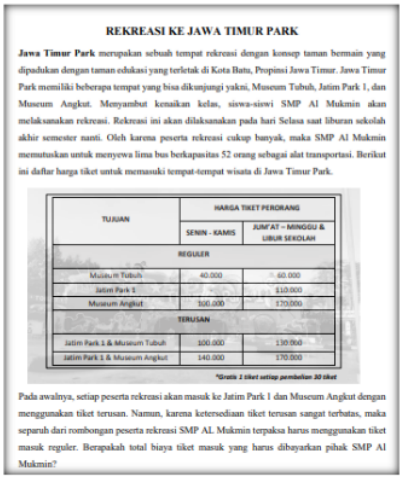
of the student learning style questionnaire, numeracy test results, and student interview results. The learning style questionnaire test was conducted by 65 students in two different schools. Based on the results of the learning style questionnaire test, the researcher conducted scoring to determine the learning style tendency of each student. The results show that 25 students have a kinesthetic learning style. After that, the researcher conducted a numeracy test. Furthermore, the numeracy test results of each kinesthetic student were grouped based on the stages of the problem-solving process. Based on the grouping results, the general form of errors made by kinesthetic students in understanding the problems was obtained. Based on the general errors, the researcher sorted into specific types of errors which were overall represented by four research subjects, namely: DV, SP, EB, and SF.

Research Instruments

The instruments in this study consisted of, numeracy problem tests, learning style test questionnaires, and interview guidelines. The three instruments are described as follows.

a. Numeracy Problem Test

The numeracy problem test consists of one numeracy problem that has been validated through expert judgment. The validation process involved experts in mathematics education who assessed the problem based on established criteria of numeracy problems, including content, construct and face validity. The results of the expert validation confirmed that the test is valid for assessing students' numeracy skills. The problems are arranged based on the criteria of numeracy problems, which consist of content, context, and cognitive level. The content is number, by representing several forms of number operations, both whole numbers and fractions. These numeracy problems take a socio-cultural as a context, which is about vacation to Jatim Park. This context expected that students can understand the story presented easily because it is so close with their daily phenomena. Furthermore, the cognitive level is the reasoning level, because it is adjusted to the definition of "problem" itself. The numeracy problem tested is presented in Figure 1 below.



REKREASI KE JAWA TIMUR PARK

Jawa Timur Park merupakan sebuah tempat rekreasi dengan konsep taman bermain yang dipadukan dengan taman edukasi yang terletak di Kota Batu, Propinsi Jawa Timur. Jawa Timur Park memiliki beberapa tempat yang bisa dikunjungi yakni, Museum Tubuh, Jatim Park 1, dan Museum Angkut. Menyambut kenaikan kelas, siswa-siswi SMP Al Mukmin akan melaksanakan rekreasi. Rekreasi ini akan dilaksanakan pada hari Selasa saat liburan sekolah akhir semester nanti. Oleh karena peserta rekreasi cukup banyak, maka SMP Al Mukmin memutuskan untuk menyewa lima bus berkapasitas 52 orang sebagai alat transportasi. Berikut ini daftar harga tiket untuk memasuki tempat-tempat wisata di Jawa Timur Park.

TUJUAN	HARGA TIKET PERORANG	
	SENIN - KAMIS	JUM'AT – MINGGU & LIBUR SEKOLAH
REGULER		
Museum Tubuh	40.000	60.000
Jatim Park 1		110.000
Museum Angkut	100.000	170.000
TERUSAN		
Jatim Park 1 & Museum Tubuh	100.000	130.000
Jatim Park 1 & Museum Angkut	140.000	170.000

**Gratis 1 tiket setiap pembelian 20 tiket*

Pada awalnya, setiap peserta rekreasi akan masuk ke Jatim Park 1 dan Museum Angkut dengan menggunakan tiket terusan. Namun, karena ketersediaan tiket terusan sangat terbatas, maka separuh dari rombongan peserta rekreasi SMP AL Mukmin terpaksa harus menggunakan tiket masuk reguler. Berapakah total biaya tiket masuk yang harus dibayarkan pihak SMP Al Mukmin?

Figure 1. Numeracy Problem Display

b. Learning Style Test Questionnaire

The learning style test questionnaire used in this study is an instrument adapted from the Indonesia Leadership & Education Consultant learning style questionnaire and stated valid by the validator. The test instrument consists of 36 statements composed of 12 questions on each modality. The learning style tendency of students is determined based on the highest score among the three modalities. However, if the student has the same score between two or three modalities, then the student is declared to have a mixed learning style.

c. Interview Guidelines

The interview guidelines used in this study contain problem-solving components described based on Polya's problem-solving stages consisting of, understanding the problem, devising a plan, carrying out the plan, and looking back. The guidelines used are declared valid. The questions compiled in this guideline aim to explore the reasons of students to carry out problem solving steps focusing in understanding the problem stage. The questions compiled in this interview guide are also not rigid questions, but are reference questions that can be developed according to conditions in the field.

Data Collection

Data collection in this study was carried out by triangulation, which combines data collection techniques in the form of learning style questionnaire tests, interviews, and documentation. The learning style questionnaire test was conducted individually at the first meeting with a maximum duration of 60 minutes. Based on the results of the learning style questionnaire test, 25 kinesthetic learning style students were obtained who then carried out the numeracy test. Furthermore, written documentation data was obtained from the numeracy problem test results. The numeracy test is carried out on the second meeting individually with a duration of 60 minutes. In this test, kinesthetic students are conditioned to sit in one row in the middle of the class to make it easier for researchers to take video which will be used as supporting data in ensuring student independence during the problem solving process. After that, based on the results of the numeracy test answers, the researcher conducted an interview session. The interview process was carried out individually by recording the sound of the conversation that took place between the researcher and each student in turn.

Data Analysis

Data analysis in this study took place during the data collection process obtained and analyzed through data reduction, data presentation, and conclusion/verification. The three processes are described as follows.

a. Data Reduction

The data reduction process began with the digitization of numeracy test results and interview data. The numeracy test result was scanned so it could be displayed in the form of images, while the recorded interview data was transcribed into dialog form. Next, the researcher categorized the subject's answer data based on Polya's stages. Based on the data

obtained, the researcher conducted coding to classify the types of errors made by the subjects based on the findings and criteria of the researcher (inductive coding).

b. Data Presentation

The researcher present the data that has been obtained in the form of figures and tables. The data in the form of pictures consists of the research subjects' answers in solving numeracy problems. Meanwhile, tabular data consists of interview transcripts as supporting data.

c. Conclusion/Verification

Based on the data obtained, the researchers identified the types of errors made by kinesthetic students in understanding the problem. Then, the researcher carried out interpretation to find out the causes and impacts arising from the errors made by the subjects. Furthermore, the researcher justifies through theories and research results that support the interpretation stage.

RESULT AND DISCUSSION

Based on the research, several forms of errors made by kinesthetic students in understanding the problem during solving numeracy problems were obtained. Furthermore, these errors are represented by four research subjects based on the types of errors made. The following are the errors made by the subjects.

1. Errors in Understanding the Problem

This type of error is the type of error that kinesthetic students generally make the most. Indicators of kinesthetic students' errors in understanding numeracy problems include:

a. Error in Stating the Information/Data Needed to Solve the Problem

Stating information/data that supports the problem solving process can be done both orally and in writing. This component is important to facilitate research subjects in developing problem-solving strategies. For researchers, this is the initial stage to recognize the subject's understanding of the given problem. Based on students' written answers, there are three examples of errors made by kinesthetic students in stating the information/data needed, including: 1) students do not stated the information/data and 2) students do not stated the information/data completely. Examples of these errors are then presented as follows.

1) Students do not Stated the Information/Data

An example of a student error that does not state the information/data is represented by DV's answer and presented in Figure 2 below.

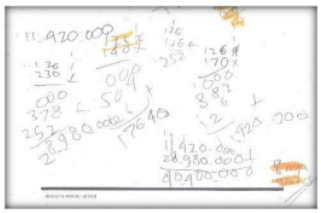


Figure 2. DV's Answer

Figure 2 show that DV did not state the information/data needed to solve the problem. This can be seen from DV's answer sheet which does not state any known information. Instead, DV immediately performed the calculation operation. In order to find out the cause of this, the following are the results of the researcher's interview with DV.

Tabel 1. Interview Transcript 1

Turn	Transcript		
1	Researcher	:	from the information that DV has mentioned before and what is asked from the problem, why did DV not write it on the answer sheet?
2	DV	:	Because I'm used to writing, right here there is already a question, I'm afraid it's not enough, like it's cramped, because this is already one sheet.

Based on the interview, DV felt that the information he needed was already presented in the problem, so DV felt no need to write it on the answer sheet. This is in line with the results of research by Sulisawati et al. (2019) which states that students with kinesthetic learning styles do not write down many things that they already understand.

2) Students do not Stated the Information/Data Completely

Some students were able to state the information/data needed, although the writing was still incomplete. An example of a student error that states the information/data incompletely is represented by SP's answer and presented in Figure 3 below.

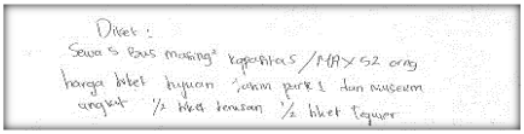


Figure 3. SP's Answer

Based on Figure 3, SP has stated the information/data. However, the information/data was still incomplete. SP state five information/data including: 1) the number of buses rented, 2) the capacity of the buses, 3) the vacation destination, 4) an information about the comparison of the number of vacation participants who use regular and pass tickets, 5) the price of admission to Jatim Park 1 and Museum Angkut. However, SP did not include information/data that the vacation was held on Tuesdays during school holidays and 1 ticket was free for every 30 tickets purchased. In order to find out the cause of the error, the following is presented the results of the interview between the researcher and SP.

Table 2. Interview Transcript 2

Turn	Transcript		
1	Researcher	:	To find what is being asked, what data and information does SP need?
2	SP	:	Use the word "Diketahui", it is known that the bus rental is 5, each capacity is 52 people, while the ticket price for Jatim Park 1 and Museum Angkut is, it can't be all, because there are not enough tickets, so it is divided in a half both. That means if 5 times 52 is 260 divided by 2, 130, meaning that 130 of them use a pass, 130 use regular tickets.
3	Researcher	:	SP can mention the information and what is asked from the problem, why did SP not write this on the answer sheet?

4	SP	:	I've forgot
5	Researcher	:	Is there any additional information that SP needs to solve the problem?
6	SP	:	I think its enough
7	Researcher	:	Do you think you have enough information to solve the problem?
8	SP	:	No, this is just the writing of 1 free ticket for every purchase of 30 tickets, enlarged.
9	Researcher	:	Did SP have time to read again to understand the problem?
10	SP	:	No I did not

Based on the interview, SP had not been able to mention the information/data completely. SP only answered 5 information needed. Furthermore, SP said that the information was enough to solve the problems. This means that SP missed an information about 1 free ticket for every 30 tickets purchased. Based on the interview, it was found that the information was missed because the writing free 1 ticket for every 30 tickets purchased was too small. This could have happened due to SP's lack of accuracy in reading. In line with this, Carbo et al. (1986) stated that students with kinesthetic learning styles are poor readers. In addition, SP just did not reread the problem to understand the problem presented. In fact, based on the results of research by Sulisawati et al. (2019) kinesthetic students need to reread 2-3 times to understand the problem well.

b. Errors in Stating What is Asked from the Problem

Stating what is asked from the problem can help students to ensure that every process carried out is oriented towards the solution of the problem. Errors in stating what is asked can cause disruption in the process of developing strategies, applying strategies, and drawing conclusions. The following are two types of research subject errors in stating what is asked from the problem. The two types of errors are presented as follows.

1) Do not Stated what is Asked from the Problem

One type of student error in stating what is asked is not stating what is asked on the answer sheet. An example of this error is represented by student EB's answer presented in Figure 4 below.

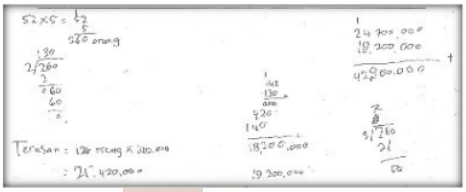


Figure 4. EB's Answer

Based on Figure 4, EB did not state what was asked from the problem. Instead, EB directly performed the calculation operation without writing down the information/data that used to solve the given problem. In order to find out why EB did this, the researcher conducted an interview with EB which is described as follows.

Table 3. Interview Transcript 3

Turn	Trancript

1	Researcher	:	Can you tell us what steps EB took after reading the table?
2	EB	:	After reading the table, I immediately thought the addition and substraction so I thought of the answer.
3	Researcher	:	Why did EB immediately think of that?
4	EB	:	Let's get it over with
5	Researcher	:	Why does it have to be done so quickly?
6	EB	:	Yes, to make it faster, to be able to play, and to finish ahead of my friends.
7	Researcher	:	EB mentioned some information earlier, why isn't it written on the answer sheet?
8	EB	:	What is known is written in the book, ee on paper, so what is here is just writing the answer.

Based on the interview, EB felt no need to write any information/data on the answer sheet, because the information needed had been written on the problem sheet. This is in line with the results of research by Sulisawati et al. (2019) which states that students with kinesthetic learning styles do not write down many things that they already understand. In addition, this process faster because students want to quickly solve the problems given so they can immediately play with friends. This is in accordance with the characteristics of kinesthetic students according to DePorter & Hernacki (2008) who state that kinesthetic students cannot sit quietly for long periods of time.

2) The Asked of the Problem Stated Irrelevant

One example of kinesthetic students' errors in stating what is asked is stating things that are not in accordance with the problems given. An example of such discrepancy is represented by SP's answer and presented in Figure 5 below.

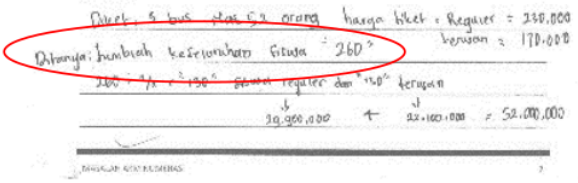


Figure 5. SP's Answer

In Figure 5, SP statement is not in accordance with the problem. The problem asked for the total cost of tickets to be paid by Al-Mukmin Junior High School to enter Jatim Park 1 and Museum Angkut, while SP (observe the red circle) wrote the total number of students 260. Furthermore, the researcher conducted an interview to find out the causes of the errors made by SP. The results of the interview are presented as follows.

Table 4. Interview Transcript 4

Turn	Transcript		
1	Researcher	:	From the given problem, what is being asked?
2	SP	:	What is asked is how many tickets and the cost.
3	Researcher	:	Then, why did SP write this sentence in the questioned part?
4	SP	:	Sorry, that's wrong
5	Researcher	:	Did SP check again before finally submitting it?
6	SP	:	No

Based on the interview, SP were actually able to mention what was asked correctly and realized the mistakes they made. This writing error can be caused by SP's lack of accuracy in working. This lack of accuracy can be caused by the absence of a looking back process carried out by students and this was confirmed in the interview. In fact, based on the results of research by Sulisawati et al. (2019) kinesthetic students need to reread 2-3 times in order to understand the problem well.

c. Errors in Interpreting Information/Data

Errors in interpreting information/data are common errors that occur when students solve numeracy problems. This is in accordance with the results of Udil & Samo's research (2023) which states that one of the common causes of errors made by students in solving numerical problems is difficulty in reasoning. There are three types of research subjects errors in interpreting information/data, including: 1) Errors in interpreting the number of vacation participants and 2) Errors in determine the entrance tickets price. Examples of information/data interpretation errors are described as follows.

1) Errors in interpreting the number of vacation participants

One kind of student error in interpreting information/data is an error in determining the number of vacation participants. An example of this error is represented by SF's answer and presented in Figure 6 below.

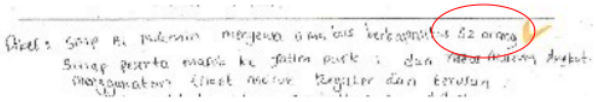


Figure 6. SF's Answer

Based on SF's answer in Figure 6, it was found that SF misinterpreted the number of vacation participants. In Figure 6, SF write that the number of the participants is 52 students (red circle), whereas in the given problem it is stated that the school rented 5 buses with a capacity of 52 people, which means that each bus rented can be filled with 52 people, so the total number of the participants should be 260 people. In order to find out the cause of the error, the researcher conducted an interview with SF which is described as follows.

Table 5. Interview Transcript 5

Turn	Transcript		
1	Researcher	:	Why does SF write the number of students is 52?
2	SF	:	Because the school rented 5 buses with a capacity of 52 people.
3	Researcher	:	What does SF think the sentence means?
4	SF	:	It means that 5 buses contain 52 people
5	Researcher	:	Please try to read the problem again
6	SF	:	Oh, 52 should be multiplied by 52, right sir?
7	Researcher	:	Why is that?
8	SF	:	I just realized, renting five buses with a capacity of 52 people means that in each foam there are 52 people.
9	Researcher	:	Why did SF just realize?

10	SF	:	Because I reread the sentence
11	Researcher	:	Does SF agree with your statement that this problem is complicated?
12	SF	:	Yes, I agree, because there is a lot of information and numbers to process.

Based on the interview, SF stated the number of the participants was 52 people because the statement "renting five buses with a capacity of 52 people" means that there are 52 people in 5 buses for SF. This indicates that kinesthetic students have a deficiency in reasoning, because in fact, it is impossible if five buses only consist of 52 people, which means there are only 10-11 people in each bus. This is in line with the results of Udil & Samo's research (2023) which states that one of the common causes of errors made by students in solving numeracy problems is difficulty in reasoning. In addition, SF students feel that the problems given are complicated, because there is a lot of information and numbers that need to be processed. This is in accordance with Wiedarti (2018) who stated that problems presented for kinesthetic students should not require a lot of writing. Furthermore, Wiedarti (2018) also stated that the problems for kinesthetic students should be presented in the form of quick problem solving, such as multiple choice, short form, or short definition.

2) Errors in determine the entrance tickets price

One form of kinesthetic students' interpretation error in the numeracy problem given is the error in determine the entrance ticket price. Examples of kinesthetic students' errors in determine the entrance tickets price are represented by EB and presented in Figure 7 below.

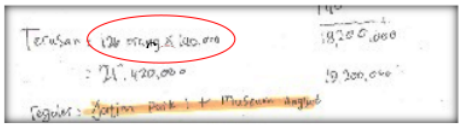


Figure 7. EB's Answer

Based on EB's answer in Figure 7, EB chose the price of 140,000 as the entrance price for the Jatim Park 1 and Museum Angkut pass. The red circle shows that EB chose the entrance ticket price on Monday-Thursday listed in the table in the given problem. This is certainly not in accordance with the information that vacation is held on Tuesdays during school holidays, so students should choose the price of entrance for Friday - Sunday & School holidays. In order to find out the cause of the error, the researcher conducted an interview session with EB, the results of which are described as follows.

Table 6. Interview Transcript 6

Turn	Transcript		
1	Researcher	:	Why did EB choose Monday-Thursday ticket prices?
2	EB	:	Because it's Tuesday
3	Researcher	:	But isn't Tuesday a school vacation?
4	EB	:	Oiya, duh! I've miss that passage.

Based on the results of EB's interviews, EB used the entrance ticket price on Monday-Thursday because EB felt that the vacation was held on Tuesday without realizing

that the vacation was held during the school holidays. The mistake made by EB can be caused by EB's lack of accuracy in reading information/data. This is in accordance with Carbo et al. (1986) who stated that students with kinesthetic learning styles are poor readers.

CONCLUSION

The results and discussion presented that there are three general forms of errors made by kinesthetic students in understanding a numeracy problem, namely 1) error in stating the information/data needed, 2) errors in stating what is asked from the problem, and 3) errors in interpreting information/data. These errors are caused by several things, including 1) students' lack of ability to interpret the reading, 2) students' lack of willingness to reread the problems presented, 3) the numeracy problems presented are complicated, i.e. presented with many numbers and objects, 4) students tend to rush to solve the problems so they do not do the reexamination process. Thus, teachers should be able to help kinesthetic students how to understand a numeracy problem better. First, practicing the students to write down the information/data used in solving the problem and what is asked completely, this will help students to plan problem solving strategies that relevant to the problem presented. Second, facilitate kinesthetic students with similar numeracy problems frequently to increase students experience in facing a numeracy problem. Third, adjusting the numeracy problems presented with the kinesthetic students characteristics such as presenting problems with information and short stories. Fifth, applying rereading. Furthermore, similar research or the development of types of problems that are in accordance with the characteristics of kinesthetic students can be carried out as a follow-up step to this research.

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