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Context of Data and Uncertainty: One of the Challenges for Numeracy Provision in Elementary School Teacher Education

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ABSTRACT

Background: Student numeracy reflects their interaction with the environment, especially with their teacher. Therefore, the formation of teacher numeracy must start from their education when in college. **Objectives**: This study explores numeracy, which parts become limited or lacking, and what hinders and supports those skills. **Design**: This study employs an exploratory descriptive method and involves case studies to achieve the objectives. **Setting and Participants**: The research participant is 84 students of the Department of elementary school education at one of the public universities in Indonesia, consisting of 3 classes: undergraduate, postgraduate, and postgraduate cooperation class. **Data collection and analysis**: Numeracy tests and semi-structured cognitive interviews are used to collect data. The test results were analyzed using descriptive statistics to see the numeracy profile, and essential parts were clarified in the discussion. **Results**: Our findings show that for all classes, statistics and probability became content with the lowest achievement on this test. We also highlight that the undergraduate class becomes the best class based on the test results, followed by the regular postgraduate class and the postgraduate cooperation class. In other words, this study's teaching experience and level of education are not enough to help students solve numeracy problems. **Conclusions**: Data and uncertainly (quantitative) literacy must emphasize improvements and potential studies for subsequent researchers. The implications of our research are also focused on teacher education; numeracy provision should not only be noted on in-service teachers but also target their education in college.

Keywords: Numeracy; elementary school education; teacher education.

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Contexto de Dados e Incerteza: Um dos Desafios para a Provisão de numeracia na Formação de Professores do Ensino Fundamental

RESUMO

Contexto: A numeração é um reflexo da interação do estudante com o ambiente, especialmente com seu professor. Portanto, a formação de numeração em relação aos professores deve começar a partir de sua formação inicial. **Objetivos**: Este estudo explora a numeracia, os aspectos limitados ou ausentes, e o que dificulta e apóia essas habilidades. **Desenho**: Este estudo emprega um método descritivo exploratório e envolve estudo de caso para atingir os objetivos propostos. **Ambiente e participantes**: Os participantes da pesquisa são 84 alunos do Departamento de Ensino Fundamental de uma das universidades públicas da Indonésia, composta por três turmas: graduação, pós-graduação e estudos de cooperação em pós-graduação. **Coleta e análise de dados**: Testes com numeração e entrevistas cognitivas semiestruturadas foram utilizadas para coletar dados. Os resultados dos testes foram analisados utilizando-se estatísticas descritivas para ver o perfil de numeração e partes importantes foram esclarecidas nas entrevistas. **Resultados**: Os resultados demonstram que, para todas as classes, a estatística e a probabilidade se tornaram o conteúdo com menor desempenho. Destaca-se, também, que a turma de graduação se torna a melhor turma com base nos resultados dos testes, seguida pela turma regular de pós-graduação e pela turma de cooperação de pós-graduação. Em outras palavras, a experiência de ensino deste estudo e o nível de escolaridade foram suficientes para ajudar os alunos a resolverem problemas de numeração. **Conclusões**: Os dados e a alfabetização quantitativa devem enfatizar melhorias e estudos por parte de pesquisadores. As implicações de nossa pesquisa também estão focadas na formação de professores, já que a numeração deve ser enfocada tanto na formação inicial quanto na formação continuada.

Palavras-chave: Numeração; ensino fundamental; formação de professores.

INTRODUCTION

We argue that numeracy is a person's skill related to their literacy of multi-context-based mathematical problems, identifying and interpreting them, processing them, then making and evaluating the right decisions to solve problems. The term numeracy is often interchangeable with mathematical literacy, as defined by The Australian Council for Educational Research on Numeracy and the OECD on mathematical literacy. The Australian Council for Educational Research (ACER, 2015) defines numeracy as the skill of "interpreting and communicating mathematical information, and using that information to solve relevant real-world problems." Meanwhile, according to (OECD, 2018), mathematical literacy is an individual's capacity to reason mathematically and formulate, employ, and interpret mathematics to solve problems in various real-world contexts. It includes concepts, procedures, facts, and tools to describe, explain and predict phenomena. It assists individuals in knowing the role that mathematics plays in the world and making the well-founded judgments and decisions needed by constructive, engaged, and reflective 21st-century citizens. In our study, we preferred to use numeracy because the scope used in various surveys is still limited to the content associated with numeracy.

Numeracy has become an interesting topic and has increased its attention in mathematics education research, primarily since the results of several international surveys, such as PIAAC, PISA, and TIMSS, provide an overview of the state of literacy in several countries involved. In addition, it makes sense when numeracy increases attention given that numeracy becomes an essential skill in one's life (Giannakaki, 2005), both for solving relevant problems and social interactions, and is also helpful in improving critical and creative thinking according to the demands in 21st-century skills, and in turn beneficial for a person to face global competition and future work (Kovas et al., 2013; Munn, 1994).

Piper and colleagues (Piper et al., 2018) mention that policymakers have been increasingly focusing on the skills students learn in schools that will later be used when they leave school. Numeracy skills become an indispensable part of the skills to live and compete. The results of international surveys are not infrequently used as the basis for education policies in each participating country, including Indonesia. Some of the unsatisfactory results from the first year of participation prompted the Indonesian government to focus on how Indonesia's ranking could be improved, which was claimed to be an improvement in the quality of education. Some of the actions taken were the implementation of nasional assessment of literacy and numeracy and also the culture of the school literacy movement.

Some studies mention that adult interactions make numeracy skills well-formed (Munn, 1994). Teachers are the focus of attention because their roles and positions are very strategic for efforts to correct and improve numeracy skills. Good numeracy skills can help teachers understand the numeracy competencies of their students (Galligan & Hobohm, 2015), how to teach them, and in turn, impact students (Shirvani, 2015; Tchoshanov et al., 2017). The importance of a teacher having numeracy skills is as a form of success in his role as a teacher, both inside and outside the classroom, even in social life (Forgasz & Hall, 2019; Hall & Zmood, 2019). In other words, developing student numeracy skills by developing the skills of supporting resources, namely teachers, is one of the strategic efforts and has also been carried out by international researchers (Golsteyn et al., 2016; Piper et al., 2018). The development of the knowledge and skills of teachers of concern is essential to strive for, but their preparation to become teachers is much more critical. The competence of pre-service teachers in numeracy and mathematics has been widely recognized as necessary in the world of education (Hine, 2015; Young-Loveridge et al., 2012).

Several previous studies have been recorded to have examined the numeracy of prospective primary school teachers, both focusing on improving their numeracy (Fisher et al., 2018; Schack et al., 2013b) and descriptions of numeracy abilities (de Silva Joyce et al., 2014; Forgasz & Hall, 2019; Sellings et al., 2018) either after treatment or without treatment. In Indonesia, we identified several studies, including Yustitia et al. (2021) which examined the numeracy of students with low abilities. However, it is not clear what kind of numeracy test is used; it’s just that judging from the students' answers, it is geometry and measurement materials. Furthermore, Basri et al. (2021) have studied students at the two universities where the research team works. This study only used one numeracy question related to data interpretation. Some of the studies that have been mentioned and contained in the literature, especially in the context of samples in Indonesia, there have not been many numeracy studies of prospective elementary school teachers that are based on complete instruments related to numeracy and comprehensively review how and what their difficulties are, on what aspects need attention, what is good and on the points that are lacking, how they differ based on their level of education and teaching experience. Our study offers that understanding for further investigation. To direct this research, two questions are asked to be explored, namely as follows.

1. What is the numeracy profile of students in general, based on test framework categories and sample classes?
2. What is the obstacle and supporting factors in solving the numeracy problem?

METHODOLOGY

This study employs an exploratory descriptive method and involves case studies to achieve the objectives. We used tests to obtain numeracy data and continued with semi-structured interviews based on the results of the tests.

Participants in this study comprised 84 students from the Department of Elementary Education at a public university in Indonesia. They were divided into three classes: one undergraduate class (S1), one regular postgraduate class (S2-R), and one postgraduate-cooperation class (S2-K). The S1 class consisted of 48 students in their fourth semester (aged 18-21), all of whom lacked teaching experience. The S2-R class included 14 students (aged 23-40) pursuing their master's degrees without prior teaching experience. The S2-K class had 22 students (aged 25-52), all of whom were teachers in the same institution and concurrently pursuing their master's degrees at the university where the second author teaches. The S2-K students were part of collaborative programs between the university and their workplace. Thus, the S2-K students had prior learning experiences. These participants were purposefully sampled, encompassing students from all three classes who were enrolled in mathematics courses taught by the second author. The assessment was conducted as a reflection of a one-semester teaching program with a focus on numeracy. Prior to utilizing the assessment tool, participants provided informed consent by signing up for the study.[1]

The instrument in this study is a numeracy test adapting the Numeracy Practice Test Question in 2019 (ACER, 2016) from The Literacy and Numeracy Test for Initial Teacher Education (LANTITE) developed by the Australian Council for Educational Research (ACER) in 2015. All pre-service teachers both undergraduate and postgraduate are required to pass literacy and numeracy tests before becoming a teacher (ACER, 2016). Since 2016, all states in Australia except New South Wales (NSW) have made passing a numeracy test a prerequisite for becoming a teacher. Passing this test will assure prospective employers and the general public that teacher graduates have good literacy and numeracy skills (O'Keeffe et al., 2017).

The test consists of 65 items with the answer form consisting of multiple choice, short answer, and true false. Of the 65 questions, 52 questions can be done with the help of a calculator and 13 questions without a

[1] This study was not reviewed by a scientific ethics committee since it is not part of a research project, but rather, it is a study that is part of the authors' motivation. Therefore, we exempt the journal Acta Scientiae from the consequences derived from it, including full assistance and possible compensation for any damage resulting to any of the research participants, in accordance with Resolution No. 510, of April 7, 2016, of the National Health Council of Brazil.

calculator. The researcher retained the original content of the entire question, only it was translated into Indonesian, and redesigned some contexts to adapt to the context in Indonesia. The test consists of three mathematical content with proportions: Numbers and Algebra (40-50%), Measurement and Geometry (20-30%), and Statistics and Probability (25-30%) (ACER, 2015). The distribution of content is shown in Table 1.

Table 1

Components of the numeracy test with each indicator

Content	Indicators	Question items
Number and algebra	Number and algebra; reasioning; ratio; fractions; percentages; decimals; budgeting; score convensions; simple formulae; basic operations	1,2,3,4,7,12,13,15,20, 21,22,23,31,32,33,37, 38,42,43,44,50,51,53, 58,59,61,62,63,64,65
Measurement and geometry	Time; scheduling; shape and space; symmetry; quantities; areas and volumes; use relevant formulae; metric units' conversion; maps; plans and scales	5,6,16,25,26,28,34,35, 39,45,52,54,55,56,57, 60
Statistics and probability	Interpreting mathematical information such as graphs; comparing datasets or sampling; interpretation; distribution; bias; validity; reliability; matching data with views: score prediction; interpreting/ calculating data; setting scores based on raw scores; drawing conclusions based on the data.	8,9,10,11,14,17,18,19, 24,27,29,30,36,40,41, 46,47,48,49

The test is carried out online through a google form that contains test questions and several supporting questions related to the identity of the participants. The google form link was shared with participants moments before the test were carried out. After successfully opening the google form, participants are given 5 minutes to read the rules for working on the test. Then the researcher provides a password so that participants can start working on the test. The test processing time is 120 minutes. In the end, after participants have finished working on the entire test section, participants are shown their scores. They will see which of their answers are right or wrong along with feedback in the form of correct answers to each question.

The test scoring procedure is to give a score of 1 for correct answers and 0 for incorrect answers so that the maximum score for the entire test is 65. Furthermore, in addition to the overall score, the test results will also be calculated based on the three components of the test and will have a score for each component. the data was then quantitatively analyzed to see the mean, median, range, and standard deviation of the data

We also conducted an interview procedure for each class represented by two participants, so that a total of 6 participants were subjected to the interview. Each of the two people is taken from the maximum and minimum scores of the numeracy test results. In the interests of confidentiality of the identity, we disguise their names, that is, for the S1 class is S1-1 and S1-2, the regular class is S2-R1 and S2-R2, and the cooperation class is S2-K1 and S2-K2.

In the semistructured cognitive interview we conducted based on the data of their numeracy test, we analyzed the points that need to be clarified in the interview. The interviews we also based on their worksheets. To dig deeper into students' difficulties in solving the problem and the causative factors, researchers used guidelines in this semi-structured interview. Questions are created based on the three numeracy processes present in the numeracy test (ACER, 2015).

Table 2

List of interview questions

Numeracy processes	Questions
Identify mathematical information and meaning in the problem.	Can you understand the point of the question? Please explain what it is! How do you identify the intent of the question?

Using and applying knowledge of mathematics and problem-solving processes	What is the strategy you use to solve the problem? Describe the stages of completion! Why did you choose that strategy?
Interpret, evaluate, communicate, and represent mathematics	Is your answer in accordance with the order of the question? Are you asked to use certain formulas or rules as taught in schools?

Interviews were conducted by the first author, then transcribed and coded based on interesting patterns. The patterns that were the theme of the main findings were discussed on an FGD basis with the second author. The results of the agreement are used to conclude the findings.

RESULTS AND ANALYSES

Numeracy Profiles between Sample Characteristics

A summary of the scores for 84 students is presented in Table 3, which consists of the overall numeracy test scores, numeracy test scores for each research class, and each score on three numeracy components.

Table 3

Summary of numeracy test results from all participants

Participant	Mean	SD	Number and algebra	Measurement and geometry	Statistics and probability
S1	45.48 (70%)	9.04	20.31 (68%)	14.00 (88%)	11.17 (59%)
S2-R	40.91 (63%)	11.14	17.57 (59%)	10.57 (66%)	9.43 (50%)
S2-K	37.57 (58%)	9.06	16.80 (56%)	12.60 (79%)	9.70 (51%)
Mean	43	10.29	19 (64%)	13 (82%)	11 (56%)

	(66%)				
SD	10.29	-	5.36	3.07	3.00
Min	22	-	8	5	8
Max	60	-	28	15	17
Total	65	-	30	16	19

In Table 3, the average score of all participants is 43 with a standard deviation of 10.29 or about 66% of the total questions that can be done correctly by all participants. Of all classes, the S1 class has the highest average with a score for the whole question of 45.48 and a standard deviation of 9.04. This figure shows that generally, students in the S1 class can do correctly about 70% of the total questions. Then followed by the S2-R class in the second position with a score difference of 4.47 from the first class, obtaining a score of 40.91 with a standard deviation of 11.14. Generally, students in the S2-R class can answer correctly around 63% of the total number of questions. Furthermore, the class with the lowest score with a score difference of 3.34 from the previous class was the S2-K class, which got an average score of 37.57 and a standard deviation of 9.06, about 58% of the questions in the test were able to be answered correctly by students in this class. From these results, it can be concluded that of the three classes, the S1 class has the highest performance with an average score of 45.48, or about 70% of the maximum score and the S2-K class has the lowest performance with an average score of 37.57 or only about 58% of the maximum score.

Each content score for all participants performed the highest on measurement content and geometry. The score of 13 with a standard deviation of 3.07 or about 82% of the total questions in this content was able to be done correctly by all participants. Continued in the second position is the content of numbers and algebras with a score of 19 and a standard deviation of 5.36. This figure shows that generally, all participants can do correctly around 70% of the questions in this content. And the last position is statistics and probability content with an average score of 11 and a standard deviation of 3.00, only about 56% of the questions in this content are ablecanered correctly by participants.

The score for each content in the three research classes is also not much different. In class S1, the highest student performance was in the measurement and geometry content with an average score of 14.00, or about

88% of measurement and geometry questions were able to be answered correctly by the participants of this class. Then the second position is the content of numbers and algebra with an average score of 20.31 or about 68% of the number and algebra questions in this test can be completed with correct answers by students in class S1. Furthermore, in the last position, there is statistics and probability content with an average score of 11.1,7 or about 59% of the questions in this content can be answered correctly by students in class S1.

Not much different from the S1 class, the S2-R class also has the highest performance on the measurement and geometry content, although with a considerable difference of about 22%. The average score of students in class S2-R on the measurement and geometry content was 10.57 or about 66% of measurement and geometry questions were able to be answered correctly by participants from this class. Then the second position is the content of numbers and algebra with an average score of 17.57 or about 59% of the number and algebra questions in this test were able to be completed with correct answers by students in this class. A difference of 9% with class S1 in the same content. Last, there is statistics and probability content with an average score of 9.43, or about 50% of the questions in this content can be answered correctly by students in classes S2-R.

The highest score in the S2-K class was also in the measurement and geometry content with an average score of 12.60 or about 79% of the measurement and geometry questions were able to be answered correctly by participants from this class. This gain is better than the S2-R class with an average score difference of 13% in the same content. Then the second position is the content of numbers and algebra with an average score of 16.80 or about 56% of the number and algebra questions in this test can be completed with correct answers by students in class S2-K. Last, there is statistics and probability content with an average score of 9.70 or about 51% of the questions in this content that can be answered correctly by students in class S2-K.

From these results, it can be seen that from the three classes, the highest performance is in the measurement and geometry content which is in the range of 80% while the lowest performance is in the statistics and probability content is only in the range of 50%. More precisely, the S1 class with an average score of 11.17 or about 59% of the maximum content score, the S2-R class with a score of 9.43 or 50% of the maximum content score, and the S2-K class with a score of 9.70 or 51% of the maximum content score. Statistics and probability content are problems for research participants in general.

Case Studies

In Table 4, the scores reflecting the highest (i.e., S1-1, S2-R1, and S2-K1) and lowest achievements (i.e., S1-2, S2-R2, and S2-K2) are presented by three students from each level participating in the test. All six of these students are female. The scores are presented based on the three contents of numeracy.

Table 4

Comparison of scores for the three participants with the highest achievement and the lowest achievement in each group

Participant	All Question	Number and algebra	Measurement and geometry	Statistics and probability
S1-1 (S1-2)	60(22)	28(9)	15(5)	17(8)
S2-R1 (S2-R2)	59(25)	28(10)	15(7)	16(8)
S2-K1 (S2-K2)	60(24)	28(8)	15(5)	17(11)
Mean (%)	92(36)	93(30)	94(34)	88(47)

As shown in Table 4, there is a very large range between the overall score of the students who have the highest scores and the students who have the lowest scores (we call them “high achievers" and "low achievers”), which is around 56%. For high achievers, the highest performance was in measurement and geometry content with an average of 94% followed by number and algebra content which was only a difference of 1% which was 93%. The lowest performance of this group is in the statistics and probability content, which is an average of 88%. In contrast, low achievers had the highest performance on statistics and probability content with an average of 47% and the lowest performance was on number and algebra content with an average of only 30%. From here we can see the difference in the achievement of each content for the two groups of students. High achievers have the highest performance on measurement and geometry content and lowest on statistics and probability, while low achievers have the highest performance on statistics and probability content and lowest on numbers and algebra. Nonetheless, with a large range, low achievers must work hard to catch up with high achievers in numeracy skills in all content.

Based on the test results, there are several questions with the largest percentage of errors. Researchers took the five questions with the most wrong answers from all participants who took the test. Table 5 presents the question number, content, and percentage of students who answered correctly on this question.

Table 5

The five questions with the most wrong answers.

Question number	Content	Percentage of correct answers
32	Number and algebra	21%
18	Statistics and probability	25%
63	Number and algebra	26%
37	Number and algebra	32%
15	Number and algebra	33%

Table 5 has presented five questions with the largest percentage of incorrect answers. In the first position, there is question number 32 with the content of numbers and algebra with the percentage of students who answered correctly only 21%, or about 18 of the 84 students who took the test. This means that about 66 students answered incorrectly on this question. Then question number 18 with statistic and probability content with the percentage of students who answered correctly by 25% and 75% of other students answered incorrectly. And continued three questions with number and algebra content with the percentage of students who answered correctly more than 25% or about 22 to 28 students from all participants.

To explore the discussion related to these five questions, we then conducted interviews with representatives of high achievers and low achievers in each class. A total of 6 participants were interviewed about how they completed the questions, based on test results and supported by worksheets they collected after taking the test. Here we present the interview results and worksheets of each question from high achievers and low achievers.

Figure 1

Question number 15

15. This is part of the information on a 167 gram packet of pasta.

Nutrient	Average quantity per serve	Average quantity per 100 g
Fat		
Total	0.3 g	0,18 g
Saturated	0,03 g	0,02 g
Sodium	668 mg	400 mg

Using the information **per serve**, what percentage of the total fat is the saturated fat?

Answer: %

Two student representatives of each group were interviewed regarding question number 15. Both of them answered wrongly on this question. The following are the results of the interviews and the attachment of worksheets from the two students.

Data S2-R1: High Achievers

S2-R1 comprehended the meaning of this question well, although she hesitated a bit when initially reading the table provided in the question. S2-R1 explains:

> *I feel that I understand the point of the problem, which is to be asked what percentage of saturated fat is in the content of pasta. I identify the problem by reading the question and looking at the table, then I immediately work on it by looking for the percentage. The amount of saturated fat divided by the weight of the paste, then multiplied by 100%.*

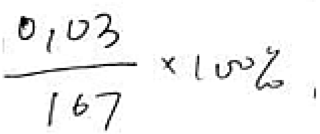
From S2-R1's explanation, it is evident that she have understood the purpose of the questions and are reasonably confident about the answers they derived based on this understanding. Subsequently, S2-R1 explained the reasons for choosing this method:

> *I selected this method as I thought it was the only method that could be used to calculate the percentage of saturated fat in instant noodles. I thought this was the correct answer and in accordance with the questions, so I didn't check the answers again. I effectively used the calculator without employing formulas, relying on the percent rule as I was taught at school… My difficulty in solving this problem was that at the beginning I was a little confused, I had to determine the percentage of saturated fat from the total fat present or the percentage of saturated fat from the total weight of instant noodles.*

Figure 2 is presented a worksheet belonging to S2-R1 which is used to obtain the correct answer to question number 15.

Figure 2

Worksheets of S2-R1



Translation:

$$\frac{0.03}{167} \times 100\% = 0.018\%$$

In Figure 2, it can be seen how S2-R1 gets the answer to question number 15. By comparing the information during the interview with the results of his work, there is an error S2-R1 in understanding the meaning of the question. In the matter, it is asked to find the percentage of saturated fat from the total fat that exists, while according to the understanding of S2-R1, the question is the percentage of saturated fat from the total weight of the paste. This misconception leads to an error in the problem-solving method used so that the answer is incorrect.

Data S2-K2: Low achievers

According to the description of S2-K2 in the interview, she faced challenges in comprehending the question's instructions. Despite reading it multiple times, S2-K2 encountered persistent difficulties in grasping the essence of the problem. S2-K2 explains:

> *I found it hard to grasp the essence of the problem. Despite repeated readings, confusion persisted as I couldn't discern the focus of the question or what to search for. I attempted to decipher the problem through repeated readings. However, due to ongoing confusion, I proceeded to work on the question. I calculated by multiplying the total weight of the pasta by 100% or 0.01, which yielded a result of 1.67.*

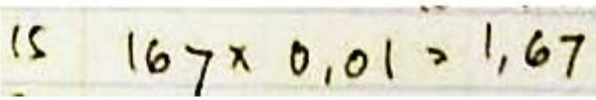
Based on the interview, S2-K2 explained how difficult she was in understanding the meaning of the questions, then she continued by explaining his reasons for choosing this solution:

> *I can't really explain why I chose this method; I was just trying my best. I'm uncertain whether my answer aligns with the question's instructions, and I didn't recheck it. I didn't employ any formulas or specific rules; it was a bit confusing for me.... My difficulty in solving this problem arose from my initial failure to understand the question's intent. I'm confused as to what percentage I should be looking for where it comes from. Too many numbers in the problem also make me doubt in solving the problem.*

The following is presented supporting the description of S2-K2, a worksheet that is made when doing the questions at the time of the test.

Figure 3

Worksheets of S2-K2



Translation:

$167 \times 0.01 = 1.67$

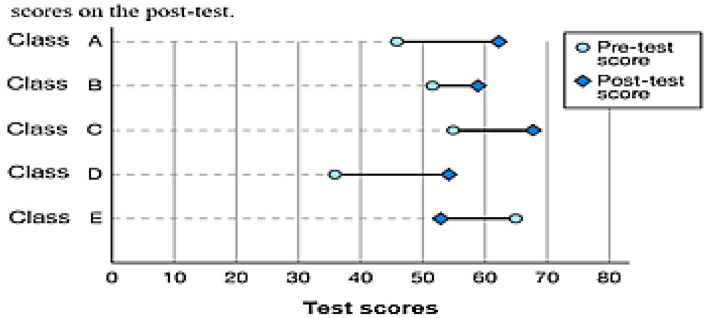
As shown in Figure 3, it is evident that S2-K2 struggled to understand the meaning of the question, this is relevant to the recognition she gave during the interview. It can be seen that from the beginning, S2-K2 did not understand the problem and was confused about the way it should be completed. According to S2-K2, she didn't know why she used that method, and just dabbled because she didn't understand what was being asked in the question.

The interview continued on question number 18. This is a question in the statistics and the probability content that was answered the least correctly by all participants.

Figure 4.

Question number 18

18. Five classes in one Year level studied the same topic. The students completed a pre-test at the beginning of the topic and a post-test at the end of the topic.
This chart shows the mean scores for each class. Most classes showed higher mean scores on the post-test.



How many classes showed **increases** of more than 10 between their mean pre-test and post-test scores?
Answer: classes

Data S2-R1: High Achievers

Based on the results of the interview, S2-R1 felt that she can understand the meaning of the question well. During her interview, she confidently explained how she understood the questions and how she identified the questions.

> *I had a good grasp of this problem; I only need to determine the class that has increased by 10 scores based on the existing chart. I can identify this problem by just reading it once, then*

reading the graph. I observed which arrows would have exceeded the range of 10 scores, and I found that there were 4 arrows.

According to her explanation, S2-R1 found a solution to this problem quite easily. She explained that he didn't even need the help of a calculator, because there was nothing to count.

I don't have any scribbles on my worksheet. I think the strategy that I use is the fastest and most appropriate for finding a solution to this problem. I am sure; I have answered according to the question instructions; I even double-checked my work.... I didn't have too many difficulties in solving this problem. It's just that I have to focus and be careful in measuring the length of the graph and the direction of the arrow.

S2-R1 does not need its worksheet to find the answer to this question, it only reads the graph to find the answer. So we will present the answers given by S2-R1 during the test and added with the information during the interview.

There are 4 classes that have increased by 10 scores, namely classes A, C, D, E

The answer to S2-R1 at the time of the test for question number 18, S2-R1 replied that 4 classes experienced an increase of more than 10 scores, but in the correct answer it was written that only 3 classes experienced an increase of more than 10 scores. There are indeed 4 classes that have more than 10 scores on the chart, but in class E there is a decrease instead of an increase. Referring to the answer, S2-R1 is less thorough in observing the direction of the arrows on the chart. she just calculated the score but did not pay attention to whether it was an increase or not, according to the order of the question. So, the answer given by S2-R1 is wrong.

Data S1-2: Low achievers

S1-2 admits that she is quite able to understand the intent of the problem but not the graph. It is quite difficult for S1-2 to read the data on the chart presented in question number 18. The following is an explanation of S1-2 regarding her understanding of the problem:

I already understood the point of the matter but was confused when I read the chart. I am very hesitant to determine which class is more than 10 scores, except for classes A and D which cross the line of 10 scores or class B which is obvious Though I've tried to identify the problem by carefully reading the chart over and over again.

Understanding the graphs presented in this problem proved to be quite challenging for S1-2. Throughout, she appeared confused and uncertain about the answer. S1-2 added:

As I remained unsure, I even attempted a strategy of counting the number of dots from a score of 0 to the position of the arrow within each class. However, this approach only increased my confusion due to varying dot counts. Ultimately, I concluded that only these two classes had scores exceeding 10... I encountered difficulty in accurately measuring the short lengths of some lines on the chart because of their close proximity. It seems that several classes are of the same size, further complicating my search for the correct answer. I tried counting the dots, but that also proved to be an unsuccessful solution.

Still in a state of confusion, finally S1-2 decided to choose the answer that 4 classes that had a score of more than 10. Similar to the S2-R1, S1-2 left the worksheet for question number 18 blank, opting to rely solely on observations from the table. Here are S1-2's responses for question number 18 during the test:

The classes that have shown improvement are 4 classes, namely: A, C, D, E.

Based on the S1-2's answers and information regarding question number 18, it is evident that at the beginning there was already an error in understanding the question. When asked to repeat the intent of the question, S1-2 does not mention the word 'increases', even though this is one of the keys in the question. So S1-2 only focuses on finding classes with a score range of more than 10. From here it can be seen that S1-2 is not careful in reading the questions so that the answers given are not by the question commands.

The interview proceeds to discussion number 32, which becomes a question with the correct answer of at least 65 questions. Students who answered correctly were only 21% or about 18 people of all participants.

Figure 5

Question number 32

32. Food dye comes in 4 colours: red, blue, yellow and green.
This table shows how to make additional colours by combining drops in the correct **proportions**.

	Red	Blue	Yellow	Green
Orange	1		2	
Purple	3	1		
Dark Green	1	4	1	
Lime Green			3	1
Aqua		2		1
Orchid	5	1		

A recipe calls for $\frac{1}{4}$ teaspoon (20 drops) of lime green.
How many drops of yellow are needed?
Answer:

Data S1-1: High Achievers

At the time of the interview, S1-1 admitted that she initially had doubts about the meaning of the question. However, after rereading it several times, she was able to comprehend it better.

> *I quite understood the intent of the matter, although at the beginning I had doubts. But after reading it a few times I quite understood it. Then I went on to read tebel. Because was I asked how many yellow drops were needed to make 20 drops of lime green, I immediately saw a box connecting the two colors. On the table it looks to form a light green color it takes 3 drops of yellow, so to form 20 drops of lime green it takes 60 drops of green color.*

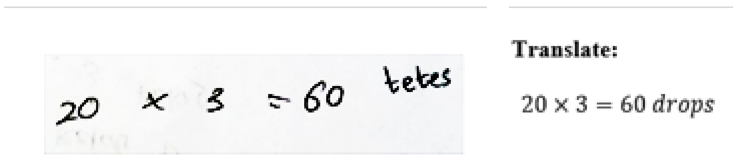
During the interview, S1-1 seemed quite confident in her answer. Even though she acknowledged her initial doubts about the intent of the questions, she arrived at a solution she believed to be correct. S1-1 also mentioned that she was quite sure about her answer because it aligned with the question's instructions. S1-1 added:

> *To work on this problem, I don't need a calculator or a certain formula. Simple calculations are all I do on my worksheets, and I have confidence in the results.… I found it challenging to understand the concept of mixing colors to form a different color. It involved finding the correct comparison, which was the most confusing part for me.*

The following is presented a worksheet collected S1-1 after the exam for question number 32.

Figure 6

Worksheets of S1-1



If you look at the answers obtained by S1-1 on the worksheet in Figure 6, there was an error made when reading the table. S1-1 focuses only on yellow and light green. If you look carefully at the table, to form a light green color, two color mixtures are needed, namely yellow and green in a ratio of 3 : 1. This is a fatal error, so even the answer obtained cannot be correct.

Data S2-R2: Low achievers

S2-R2 admitted that she was unable to understand the meaning of the question. Although she has repeatedly read the questions and observed the table, she still has difficulty understanding the prompts of the questions. Here's the description of S2-R2:

> *I don't understand the point of this matter. I don't know the question sentence and the table. I've also tried to identify the*

problem by reading from the table's instructions but still don't understand.

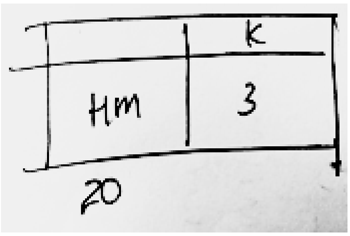
According to the statement, S2-R2 found it very difficult to understand the meaning of the questions. When the researcher showed the same problem during the interview and asked S2-R2 to try to understand this problem again, she looked still very confused and admitted that she did not know what was asked in the problem.

I have tried to answer the questions by separating the tables according to the questions, namely light green and yellow, then the number three in a parallel box. I was still confused about where to finish the problem from, and in the end, I didn't continue it…. Overall, I have difficulty in understanding this matter. I am very confused in understanding the numbers in the table and their relationship to the question commands. I only know what color to ask for, but don't know which number to use.

S2-R2 explained that until the end she could not find the answer to this question. The following is presented a worksheet belonging to S2-R2 that she wrote when she tried to answer the question.

Figure 7

Worksheets of S2-R2



Translation:

	Yellow
Lime green	3

20

Based on S2-R2's admission during the interview and the information provided in Figure 7's worksheet, it's evident that she cannot understand the meaning of the question, as there is no answer recorded on the worksheet. S2-R2 has not been able to interpret the question commands well, then plus its inability to read the table. Researchers observed at the time of the interview, that S2-R2 was not that serious when reading the initial instructions of the question or table instructions. In fact, in this initial instruction, information has been presented that can make it easier for participants to read the table so that the questions on the questions will be easier to understand.

Moving on to question number 37, where only 32% of students answered correctly. This question can be seen in Figure 8.

Figure 8

Question number 37

37. Two students at a school participate in a step challenge to raise money for charity. They record the number of steps they walk each day for one 10-week term. This table shows the steps they have recorded at the end of **week 6** (42 days).

Name	**Total number of steps**
Gabrielle	262.000
Shay	366.000

Gabrielle wants to reach a total of 500 000 steps at the end of week 10.
What is the average number of steps Gabrielle will need to walk **each day** for the next 4 weeks (28 days) to reach her goal?
Jawab: steps each day

As before, interviews were conducted with two representative students of the group. High achievers were represented by S2-K1, while low achievers were represented by S1-2.

Data S2-K1: High Achievers

Based on the interview results, S2-K1 claimed to be able to understand the questions very well. She explained how she comprehended the problem and approached it:

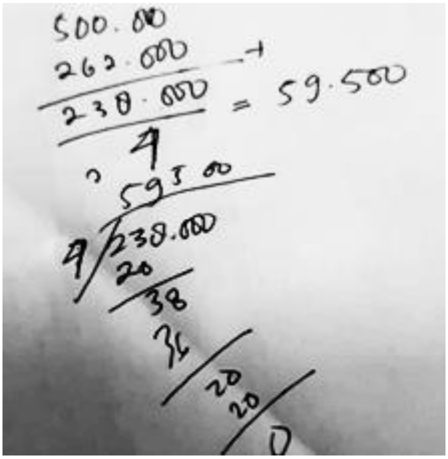
> *I can understand the problem very well. In this question, we are asked to determine how many steps Gabrielle needs to complete the challenge in the last 4 weeks. I identify by reading the question well, then marking what is known in the question and what is asked. Last saw the extra information on the table and I was able to work on it right away.*

When the S2-K1 interview sounded confident enough, it was seen that doing this problem was not a problem for him. With one read of the problem, she was immediately able to find a solution. Figure 9 presents S2-K1's worksheet for solving question number 37. She explained how the solution was used:

> *First I identify the total steps grandma has to complete, then I subtract the steps already taken from this total. Finally, I divide the obtained steps by 4 weeks. I use this strategy because it aligns with the flow of the questions, and my answers adhere to the instructions. To solve this problem, I don't use any formula, only simple arithmetic operations…. My main challenge in solving this problem is performing the calculations, as there are several steps in the question that require multiplication to arrive at the correct answer.*

Figure 9

Worksheets of S2-K1



Translation:

500,000 – 262,000 = 238,000

238,000 ÷ 4 = 59,500 steps

From the interview results and the worksheet in Figure 9, S2-K1 has used the correct solution to solve the problem. Errors arose during the division step. In the matter, the steps are asked for each day, but S2-K1 is looking for steps for each week. Here it can be seen that S2-K1 is not careful in reading the question commands and causes the answers obtained to be wrong.

Data S1-2: Low achievers

The interview continued with the S1-2. S1-2 admitted that it was quite difficult to understand the questions and was confused by the question commands.

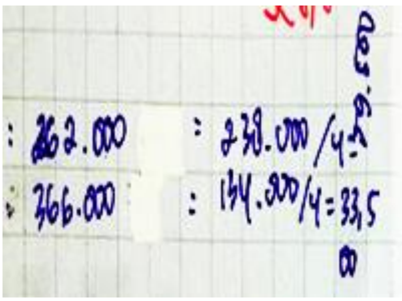
> *I'm confused by the point of the matter, if it's on the table, I have no problem. I've tried to identify the question by reading it slowly, but am still confused as to what the question is asking for. Finally, I tried to solve this problem by subtracting the total steps by Gabrielle's steps and Shay's steps based on the table, then I divided by 4 weeks. I'm not too sure of my answer.*

S1-2 admitted that she was not sure of his answer to this question, this was because from the beginning it was difficult to understand the command of the question. Her worksheet, as presented in Figure 10, further illustrates her difficulties.

> *Actually, I've had a little difficulty in understanding the problem. Plus the question command to count the number of grandma's steps with several conditions. I am confused about which number to multiply in order to find the desired answer to the question.*

Figure 10

Worksheets of S1-2



Translation:

Gabrielle:

500,000 – 262,000 = → $\frac{238{,}000}{4}$ = 59,500

Shay:

500,000 – 366,000 → $\frac{134{,}000}{4}$ = 33,500

Looking at the worksheet belonging to S1-2 in Figure 10, it becomes evident that S1-2 has difficulty in understanding the commands of the questions. In the matter of only being asked to look for the rest of the steps Gabrielle had to take in the last 4 weeks, but S1-2 tried to find also for Shay's own move. Furthermore, in the worksheet, S1-2 attempted to divide the steps by four weeks, which was also an incorrect step. S1-2's inaccuracies in interpreting the question suggest that she did not fully comprehend it, leading to incorrect responses.

The last interview was then conducted for question number 63, which also the content on numbers and algebra. This interview was also conducted on two student representatives of the group.

Figure 11

Question number 63

63. A physical education teacher wants to hire a dance instructor to conduct some classes.
The dance instructor charges Rp.250.000 for each class.
However, when 3 classes are booked at the same time, a 20% discount off the total cost applies.
What is the cost of three classes when booked at the same time?
Answer:

Data S1-1: High Achievers

For question number 63, S1-1 admitted that she had no difficulty working on it. The questions were quite easy to understand, even with just one reading of the questions.

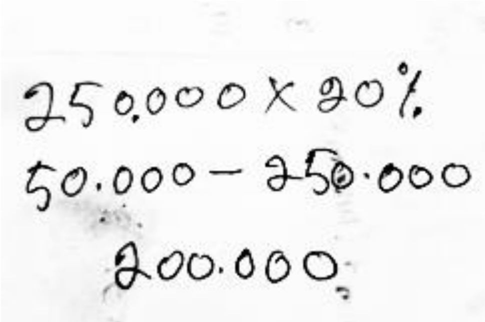
> *I understand the meaning of the problem, which is asked how much tutoring costs in groups of 3 students. I read carefully to identify the question and mark what is known in the question. I started working by looking for 20% of the 250,000. Then I get a result of 200,000 that must be paid after deducting the discount.*

During the interview, S1-1 appeared confident in explaining how she approached this problem. She expressed certainty in her answers:

I am quite sure of my answer. This is the only way I can think of to solve this problem. I even double checked my answer. I don't use a specific formula, I just use the percent rule to find the discount amount… I'm not having too much trouble solving this problem. It's just that I'm a little hesitant in calculating the percentage according to what is asked in the problem. However, in the end, I was able to answer properly.

Figure 12

Worksheets of S1-1



Translation:

250,000 × 20% = 50,000

250,000 – 50,000 = 200.000

In Figure 12, it becomes apparent that S1-1's answer does not match the correct answer. Despite her claim, S1-1 seems not to understand the meaning of the question. The question asked for the cost of group tutoring for three students, but S1-1 interpreted it as the cost of tutoring for each individual, leading to these inaccuracies. Although the strategy of working on the questions used is quite appropriate, the mistakes of S1-1 in understanding the intention of the questions make the incorrectly obtained answers.

Data S2-K2: Low achievers

According to S2-K2's statement during the interview, She also felt quite able to understand the meaning of the questions. Here's the explanation from S2-K2:

I'm quite able to understand the point of the matter. In the question, it is asked to calculate the cost of group tutoring for

3 students. I identified this problem by reading it repeatedly, then recording the information on the question. From the questions I got information on the cost of tutoring of 250,000/month, youth for 3 students got a 20% discount, so I multiplied 20% by 250,000, and I got the answer 50,000

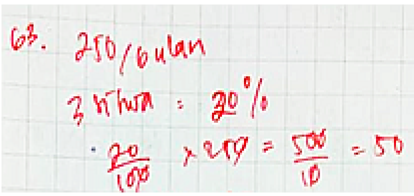
Although she admitted to having a reasonable understanding of the questions, S2-K2 appeared somewhat hesitant when explaining her approach to solving them during the interview. She added:

> *Although not completely, I am quite sure of my answer. I didn't have time to check my answer for this question because time was running out. I don't use any formula in working on the problem, I choose this way of finding percentages because it is in accordance with the instructions for the problem...I feel that I can understand the meaning of the questions well, but when doing the calculations I have a little doubt. There were stages I needed to complete and I didn't complete them.*

According to her confession, although not very sure, S2-K2 felt that the answers obtained had been done by the order of the questions. The following worksheet belongs to S2-K2.

Figure 13

Worksheets of S2-K2



Translate:

250/month

3 students = 20%

$\frac{20}{100} \times 250 = \frac{50}{100} = 50$

By comparing the worksheet with the S2-K2 explanation, there are quite different. When asked to explain the meaning of the question, S2-K2 quite well explains the understanding of the problem. However, when reviewing the worksheet, it becomes clear that S2-K2 has not fully grasped the problem's intent. The question asks for the cost of group tutoring for 3 students after the discount. S2-K2 only works on the question of up to the amount of the discount, it is even just a discount for one person. There are still many steps to work on the problem that she has not done. S2-K2 has not been able to answer correctly on this question because it has not been able to understand the question commands.

DISCUSSIONS

The results showed that there were differences in the average score in the three classes. Class S1 is the class with the best test results, where the average student can answer about 70% of the total questions. This class contains elementary school teacher education students who all have no teaching experience at all and have been in elementary school teacher education for 2 years. This result is certainly very good because as a prospective elementary school teacher, it is very important to have good numeracy skills. This is relevant to research conducted by Schack et al. (2013) which states that it is important for prospective elementary school teachers to have good numeracy skills to later be able to see the numeracy abilities of their students.

In the second position is the S2-R class, where the average student in this class is able to answer around 63% of the total questions. Class S2-R consists of two groups of students who have not taught and who are teaching. About 40% of the students in this class have had teaching experience. Furthermore, in the last position, there is the S2-K class, whose average student is only able to answer about 58% of the number of questions. All students in this class are teachers who are active and are continuing their postgraduate education. This result is unfortunate given the enormous role of teachers in helping to develop the numeracy skills of elementary school students.

One of the problems that arises in students with teaching experience (teachers) is that they have difficulty recognizing the mathematical elements inherent in a situation or problem presented in the problem. For example, question number 32 which has been presented in the results section with the context of the question about the formula for determining colors that refer to the comparison material. Most of the participants did not realize that this question was a matter of comparison. This lack of ability caused participants to be unable to find the right solution. This is relevant to the results of the research of Callingham et al. (2015) who explained that the absence of 'mathematical thinking in problem-solving allows a person to ignore the counting aspect and miss information that plays an important role in problem-solving.

When interviewed some teachers admitted that they were indeed less skilled in mathematics, because the focus of their studies was not in this field. Some teachers state that they are more skilled in social studies or art. This can be another factor in teachers' low numeracy skills. This is relevant to several studies (Callingham et al., 2015; Fisher et al., 2018; Md-Ali et al., 2016; Forgaz et al., 2017) who mentioned that several factors cause low teacher numeracy skills, including teachers claiming to dislike or actively avoid mathematics; teachers feel they have their focus; the teacher feels no need to develop knowledge, all that is needed is experience. These kinds of thoughts cause the numeracy development opportunities of students in schools to be neglected. Whereas as previously explained that numeracy is very important for students in fulfilling the demands of their daily lives.

In aspects of content, these three classes have the same performance. In all classes, measurement and geometry content is the content with the highest score, where the average student in each class can answer about 82% of all measurement and geometry questions. The question in this context that is most answered correctly is the problem of calculating the area and volume by utilizing the formula they already know. Some small errors that occur when solving this problem are forgetting to convert units according to the question command.

The content with the lowest score is statistics and probability. This applies equally in all research classes. The average student is only able to answer 56% of all statistics and probability questions. This became the most difficult content in this test for participants. For this content, participants generally make mistakes in questions that include tables or graphs. Based on the results of the interview, participants admitted that they had difficulty analyzing the information presented in the form of tables and graphs.

In other parts, the results of the study also showed a fairly clear difference between high achievers and low achievers. High Achievers were able to answer about 92% of all questions while the lowest group was only able to answer 36% of the questions. From the results of interviews and worksheet analysis, it was found that there were differences in the numeracy process between students in the two groups. In the first process of numeracy, it is an activity to identify information and mathematical meanings in the problem. In this process, participants identified or extracted the mathematical meaning of the problem, then contextualized it (Felani et al., 2018). The clarity and complexity of mathematical information that participants can obtain from the problem determine the success of this process. This first process largely determines the success of the next process. Both high achievers and low achievers, in general, have carried out this process well, although there are some cases in low achievers that are still difficult to get through this process.

The process of identifying problems is carried out by students generally by reading questions, tables, or graphs on the questions, then recording information that they consider important. This is relevant to Sumirattana et al. (2017) who explain that the process of identifying a problem is generally carried out by reading the problem to understand its intent and then paraphrasing the problem in one's language. Some of the cases that occur in low achievers are failure to distinguish between relevant information and irrelevant information in the matter. This error occurs most in questions with tables or graphs. Then it makes an error in obtaining information that will be used to find a solution to the problem. The same case has been discussed by Krawec (2014) in his research which states that because problems allow containing irrelevant information, many participants are less selective in choosing information to paraphrase. The results showed that students from low achievers had more significant difficulty in identifying the meaning of the question.

The second process of numeracy is related to the use and application of mathematical knowledge, then the process of solving problems. Related to the ability to think mathematically explicitly, including thinking activities, the use of various mathematical skills, and the use of methods, strategies, and tools by participants in solving problems (Fahrudin et al., 2019). In this process, students make estimates, choose the right methods and solutions, and use the information that has been obtained in the previous process. Problem identification is an important step to determine the success of problem-solving. This is relevant to the research of Sumirattana et al. (2017) which explains that effective problem solving begins with good identification of the problem, by obtaining accurate information describing parts of the problem.

Errors that occurred in the previous process will greatly affect this process. Information that is not needed in the problem will only complicate the problem-solving process (Krawec, 2014). The results showed that there were still many participants who made mistakes in this process due to a lack of mathematical knowledge. For example, such as the error of applying the formula and the method used or the error of entering information into the formula used. Relevant to the opinion of Mulyono & Hadiyanti (2018) which explains the failure of the problem-solving process can come from failure to identify problems, errors when converting information into mathematical language, and errors in the application of formulas or solutions used.

Other results show that low achievers students are still unable to plan strategies or steps in solving problems so the chosen strategy is incorrect and unclear. Meanwhile, high achievers are good at strategic planning, but sometimes there are still students who have difficulty implementing strategies so that the work is not by the plan that has been prepared. This case is relevant to the results of research conducted by Yustitia et al. (2021), prospective elementary school teachers with low abilities have been able to identify and find some relevant information, but they have not been able to involve procedures and develop the information that has been obtained. While prospective elementary school teachers with high abilities can identify, find relevant information, and involve known mathematical procedures and rules, errors occur when communicating not by the results obtained. Planning problem-solving strategies and using the information obtained determines the success of problem-solving and shows the level of formal thinking (Rahman & Ahmar, 2016).

Participants' weaknesses in developing their reasoning ability affect their ability to solve problems. There is a considerable gap between the two groups in the problem-solving process. This difference can be seen in the mistakes made by the majority of high achievers occur due to calculation errors or inaccuracy in identifying information in the problem, while mistakes made by low achievers mostly occur due to inability to formulate problem-solving strategies or lack of mathematical knowledge which causes them not to know which formula to use to solve a problem. Success in problem-solving with planned strategies distinguishes a person's cognitive maturity (Fahrudin et al., 2019).

The last numeracy process is the activity of interpreting, evaluating, communicating, and representing mathematics. This stage also includes the ability of participants to use mathematical symbols in general, and make conversions and representations on tables and graphs. Proper use of symbols can be one of the determinants of successful problem-solving. Use the most basic combinations of symbols such as $+, -, \times, \div$ or fractional shapes such as 1/100, 20%, 0.03. There are still students, especially low achievers, who are still wrong in using symbols or converting such as 0.03 into the form of percent is 3%, or calculating 10% of 0.3. Lack of thoroughness in the use of symbols, errors in making conversions, then inability to perform mathematical representations are one of the causes of participants' failure to complete this test.

Mathematical representation is important in solving mathematical problems. Representation supports students in understanding problems to communicate ideas or solutions that will be applied to problems (Nirawati, 2018). This test generally performs numerical representations such as decimal, fractional, or percent formats. After performing the representations, the next step is to communicate. Mathematical communication is an activity using mathematical language to describe mathematical processes and problem-solving directly or in writing (Lomibao et al., 2016). The results of the communication describe the representation process carried out by each student in this test. Regardless of how the results are, this process has been carried out by students through their interviews and worksheets. At the evaluation stage, participants mostly only check the results, without checking the process. Lack of care in examining the process and the results of problem-solving at the end sometimes makes the work futile (Mulyono & Hadiyanti, 2018).

CONCLUSIONS

The results showed that teaching experience does not determine a person's numeracy skills. Students who do not have teaching experience can get better results in numeracy tests than students with teaching experience. The results showed that both low achievers and high achievers participants had difficulty in doing the test. The highest participant difficulty in this test was in statistics and probability content. Low achievers participants have been able to identify and find some relevant information in the questions, but they have not been able to develop the information that has been obtained and involve problem-solving procedures. While high achievers participants were able to identify, find relevant information, and involve mathematical procedures and rules that they knew, errors occurred when communicating not by the results obtained.

The teacher's ability to reasonably handle basic math skills can be expected of the elementary school teacher. This research was driven by concern for the basic standards that pre-service teachers should have. Because the students studying in the elementary school teacher education study program come from a variety of different majors, it is conceivable that all students have varied mathematical backgrounds. Plus, there are no specific courses related to this numeracy available in the curriculum. Students are also not required to pass a numeracy test before graduating at the primary school teacher education level. This is an important basis for conducting numeracy tests on prospective teacher students to measure their numeracy skills. The results of our research cannot be generally enforced. Many other conditions can affect the results of this numeracy test, but research can be used as a reference to conduct further research, especially on teachers and prospective elementary school teachers.

AUTHORS' CONTRIBUTIONS STATEMENTS

SDA and YWP conceived the presented idea. SDA preparing test questions and conducting interviews with participants, performed the activities, and collected the data. YWP plays a role in conceptualization, preparing conceptual frameworks and structuring research procedures, collected the data, and writing – review & editing. SDA and YWP analyzed the data. Both authors actively participated in the discussion of the results, and reviewed and approved the final version of the work.

DATA AVAILABILITY STATEMENT

The data that support the results of this study will be made available by the corresponding author, YWP, upon reasonable request.

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