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Numeracy Skill in Learning Mathematics for Elementary School Students: How Sociomathematical Norm Becomes a Category in the Characteristics of Epistemological Obstacles

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Abstract: In the last decade, several studies have concluded that numeracy skills are the basis for elementary school students' development of mathematical abilities. To examine numeracy skills, categorical variables from the affective domain are needed, namely socio-mathematics norms. This study aims to identify the characteristics of epistemological obstacles to elementary school students' numeracy skills in relation to socio-mathematical norms. The method used in this research is a case study involving 6 respondents, divided into 3 categories of sociomathematical norms: high, medium, and low. The study found that students' epistemological obstacles in numeracy vary by their socio-mathematical norms. Students with low norms faced significant conceptual misunderstandings, such as regarding length, area, and volume, and procedural issues, such as skipping known information. Medium-norm students had similar conceptual and procedural challenges, indicating a need for targeted interventions. High-norm students generally showed strong conceptual understanding and problem-solving skills but occasionally struggled with structured completion. These findings emphasise the importance of incorporating socio-mathematical norms into teaching to improve mathematical understanding and problem-solving strategies. At the same time, technical operational obstacles were minimal; addressing these epistemological barriers is essential for developing effective, tailored instructional approaches.

Keywords: Numeracy, Sociomathematical Norms, Learning Mathematics, Elementary School

Introduction

Epistemological obstacles within the sociomathematical norm category manifest in various ways, such as conceptual misconceptions, procedural errors, and operational difficulties (Reusser, 2000). Conceptual obstacles may arise from differing cultural interpretations of mathematical symbols or concepts, impacting a student's grasp of fundamental numerical ideas (Perbowo & Anjarwati, 2017). Procedural obstacles may stem from variations in problem-solving approaches influenced by cultural norms, leading to misconstrued methods or skipped steps (Fuadiah, Suryadi, & Turmudi, 2016). Operational challenges could be tied to societal attitudes towards specific mathematical operations, affecting a student's comfort and proficiency with certain mathematical techniques ,(Rittle-Johnson, Schneider & Star, 2015). By recognising and addressing these sociomathematical influences, educators can implement more targeted, culturally responsive teaching strategies to enhance numeracy skills and foster a deeper understanding of mathematics among elementary school students.

Within the realm of numeracy skill development, the sociomathematical norm emerges as a critical category influencing the characteristics of epistemological obstacles encountered by elementary school students. Sociomathematical norms encompass the social and cultural aspects that shape an individual's mathematical understanding (Baki, 2023; Morrison et al., 2021; Dickes et al., 2020). In the context of numeracy skills, these norms can act as both facilitators and barriers (Windisch, 2015). Students from different social backgrounds may approach mathematical problems with varying perspectives influenced by their cultural contexts. Understanding the sociomathematical norm is pivotal for educators, as it enables them to identify potential challenges arising from cultural differences, language barriers, or societal expectations that could hinder students' comprehension and application of numeracy skills (Sánchez & García, 2014).

Many studies have examined epistemological obstacles to mathematical numeracy skills in learning mathematics. Research conducted by Fitriana et al., (2022) which examined the barriers to numeracy skills concluded that the obstacles that occur in elementary school students in developing numeracy skills include understanding the meaning or meaning contained in problems based on aspects of mathematical resilience. Another study ▯ revealed the obstacles students face in numeracy, namely their lack of understanding of basic mathematical concepts. Furthermore, a study concluded that in the process of mathematical numeration, some students could not complete the result of their understanding of the meaning of numbers and errors in the addition operation involving negative integers (Fuadiah et al., 2016). Research has Aunio et al. (2015) concluded that some of the obstacles faced by elementary school students in learning mathematics include low learning arithmetic skills, difficulties in learning arithmetic, and problems with number sense abilities. Another study on barriers to learning numeracy was conducted by Rakhmawati & Mustadi (2022), who concluded that students' interest in numeracy could be developed. However, there were obstacles to understanding numeration problems, such as difficulty with stories and giving up when facing difficult problems. Several studies have been conducted, and many have examined obstacles to developing numeracy skills. In this study, there is still little mention of numeracy skills, affective aspects, or soft skills, especially regarding sociomathematical norms. Although the cognitive aspects of learning are essential for developing mathematical abilities, it is necessary to examine the barriers to students' numeracy skills in relation to affective aspects, including sociomathematical norms.

The research gap in the context of numeracy skill development and sociomathematical norms lies in exploring how sociocultural factors impact the emergence and resolution of epistemological obstacles among elementary school students. While existing literature acknowledges the influence of sociomathematical norms on students' mathematical understanding (Yackel & Cobb, 1996), there remains a need for more empirical studies that examine specific instances in which cultural backgrounds intersect with the acquisition of numeracy skills. Understanding how different sociomathematical norms contribute to conceptual, procedural, and operational challenges within diverse student populations can provide valuable insights for educators striving to create inclusive and effective learning environments (Pang, 2000). Additionally, research exploring the effectiveness of various teaching strategies tailored to address sociomathematical influences on numeracy skill development can further bridge this gap, offering practical recommendations for educators seeking to enhance mathematical learning outcomes for all students.

Developing numeracy skills requires engaging in a social process known as socio-mathematical norms. Yackel & Cobb, (1996) define socio-mathematical norms as individuals' understanding of mathematical activities, emphasising efficiency and elegance. Kang & Kim (2016) elaborate that these norms involve considering diverse mathematical perspectives and explanations. They help enhance students' confidence and foster collaborative learning in mathematics, ultimately promoting positive mathematical thinking (Maarif & Fitriani, 2023). Thus, socio-mathematical norms significantly influence the development of students' numerical abilities.

Fagerlin et al., (2007) have revealed that the basis for developing early mathematical abilities in elementary school students is the development of logical thinking, the teaching of conventional arithmetic methods, and learning in real-world contexts. Numeracy skills are included among the basic thinking skills, which involve the ability to compare, classify, count, make statements, and understand the correspondence between mathematical concepts (Toll & Van Luit, 2014). In the process of developing numeracy skills, it is not uncommon to encounter obstacles in understanding several concepts when solving problems. Epistemological obstacles in the process of learning mathematics become one of the obstacles to understanding students' numeracy.

Several studies have revealed obstacles in developing numeracy skills including: difficulties in understanding the meaning contained in the problem (Fitriana et al., 2022), lack of students' understanding of basic mathematical concepts (Rakhmawati & Mustadi, 2022), an error in the addition operation involving negative integers (Fuadiah et al., 2016), do not understand numeracy problems in the form of stories and give up in facing difficult problems (Rakhmawati & Mustadi, 2022). To identify epistemological obstacles to numeracy skills, a categorical variable is needed to map them more specifically. One of the categorical variables in the affective domain is the sociomathematical norm, which can foster students' self-confidence as they learn mathematics together in groups, thereby playing a positive role in developing mathematical thinking processes (Samsul Maarif & Fitriani, 2023). Therefore, sociomathematical norms are strongly related to the development of students' thinking, including their numeracy skills. The research question posed in this study is: how are the epistemological characteristics of elementary school students' numeracy skills grounded in sociomathematical norms?

Literature Review

Numeracy Skill

The process of learning mathematics at every level of education is expected to improve mathematical competence, in line with the learning objectives. Mathematical competence is one of the determinants of the success of educational goals, the process of thinking when solving problems in everyday life, developing a collaborative attitude, developing resilience, professional achievement, and even the economic growth of a nation (Seitz & Weinert, 2022). Therefore, it is inevitable that the development of mathematical competence be carried out from an elementary age, especially for mathematical numeracy skills. Numeracy skills are basic mathematical abilities that are used in everyday life, including basic arithmetic skills, comparisons, shape recognition, and problem solving(Singh et al., 2021). Numerical abilities are important in every process of learning mathematics, especially in elementary schools.

In the last decade, several studies have concluded that numeracy skills are the basis for elementary school students' development of mathematical abilities (for example, Toll & Van Luit, 2014; Aunio et al., 2021) Seitz & Weinert, 2022; Artigas, 2023). Several studies have concluded that early childhood numeracy focuses on arithmetic skills and information. (Litkowski et al., 2020). Further research results LeFevre et al., (2010) have proven that numeracy skills can be developed through home education, making a difference for children before they enter formal education. In addition, research results Kiss et al., (2019) concluded that one predictor of success in developing mathematical competence is students' initial mathematical ability to perform mathematical calculations in numeracy. Therefore, based on several research results, it is necessary to conduct an in-depth study of numeracy skills, especially at the elementary school level, given the various obstacles to learning.

Epistimological Obstacle

In general, the obstacles that arise during the learning process hinder the development of thinking and understanding of mathematical concepts (Bakar, Suryadi, & Darhim, 2019). Brousseau, (2011) said that obstacles in mathematics are divided into 3 categories, namely: 1) ontogenical obstacles: an obstacle that is a mental maturity of a person in the thought process due to age and cognitive maturity; 2) didactical obstacles: are obstacles to the learning process including strategies, approaches, learning models that havestudents been experienced; 3) epistemological obstacles: are obstacles to understanding a mathematical concept from the learning process that has been carried out. These three obstacles may arise during the development of students' numeracy skills. Therefore, of the three obstacles disclosed in the development of numeracy skills, it is necessary to analyse the epistemology of mathematical concepts more deeply. Thus, these obstacles can be minimised in order to develop students' numeracy skills.

Epistemological obstacles in developing numeracy skills are significant. This is in accordance with research results, which reveal that, to develop mathematical numeracy skills, a thorough understanding of mathematical concepts is necessary to avoid misunderstandings in constructing knowledge (Jimenez & Kemmery, 2013). Epistemological obstacles are generally divided into three types, including: conceptual obstacles, procedural obstacles and operational technical obstacles (Maarif, Perbowo, et al., 2021). These three obstacles can arise for students as they develop numeracy skills. For example, a student learning the multiplication concept in numeracy usually has difficulty understanding the meaning of "$2 \times 5 = 5 + 5$ or $2 \times 5 = 2 + 2 + 2 + 2 + 2$". This indicates that there is a student error in understanding the concept of multiplication, which leads students to experience conceptual obstacles. Another example of solving fractional numeracy problems: students face procedural obstacles when working with mixed fractions by involving the numerator and denominator, indicating that they experience procedural obstacles in thinking numerically. Therefore, it is necessary to analyse further how epistemological obstacles in developing numeracy skills can be identified as material for determining the learning process.

Sociomathematical Norms

Sociomathematical norms, a term coined by Yackel & Cobb (1996), encapsulate the social dynamics and shared conventions governing mathematical interactions within learning communities. These norms extend beyond individual cognitive processes to encompass the collective practices, values, and expectations surrounding mathematical reasoning and discourse (Baki, 2023). Rooted in sociocultural theories of learning, sociomathematical norms provide a lens for understanding the social construction of mathematical knowledge. Drawing from Vygotsky's notion of the zone of proximal development (ZPD), sociomathematical norms emphasise the collaborative nature of learning, wherein students engage in joint problem-solving activities and negotiation of meaning (Yackel, Rasmussen, and King 2000; Maarif et al. 2024).

Sociomathematical norms manifest in various classroom practices and discourse patterns. Research suggests that classrooms with positive sociomathematical norms encourage open-ended problem-solving, promote diverse mathematical strategies, and value students' contributions to mathematical discussions (Güven & Dede, 2017). Conversely, classrooms characterised by harmful norms may stifle student participation and perpetuate misconceptions about mathematical ability. Cultural perspectives intersect with sociomathematical norms, shaping students' mathematical experiences and identities. (Zembat, Yasa, & Using, 2015) highlights the importance of recognising diverse cultural practices and mathematical traditions within classrooms. Culturally responsive teaching acknowledges and leverages students' cultural assets, challenges deficit perspectives, and promotes equitable learning opportunities.

Sociomathematical norms have profound implications for equity and access in mathematics education. Studies reveal that certain groups of students, particularly those from marginalised backgrounds, may face barriers to participation and recognition within classrooms characterised by restrictive norms (Symeonidis, Tatsis, & Kaldrymidou, 1990). Addressing inequities in sociomathematical norms is essential for fostering inclusive learning environments and promoting social justice in mathematics education. Effective teaching practices play a critical role in shaping sociomathematical norms within classrooms. Teacher professional development initiatives often focus on fostering a supportive classroom culture, cultivating students' mathematical identities, and promoting equitable participation (Yackel et al., 2000). By empowering teachers to recognise and challenge inequitable norms, professional development efforts help create more inclusive mathematics classrooms.

Materials and Methods

Research Design

The research method used is a case study. A case study is an ethnographic study that focuses on a unit of research, such as individuals, groups, or programs, to examine an event within that unit to obtain a detailed description of the unit (Tanujaya et al., 2017). A case study was conducted to examine the characteristics of epistemological obstacles to elementary school students' numeracy skills in relation to sociomathematical norms, to articulate and understand the conceptualisation of subject-specific participation. This research was conducted with several approaches, namely interviews, observation and archiving. This study involved 14 elementary school students as participants. A total of 6 participants completed the sociomathematical norm questionnaire as a basis for categorisation and took a numeracy skill test.

Data Collecting

The research begins by categorising respondents' sociomathematical norms into three categories: high, medium, and low. As many as 14 respondents completed the sociomathematical norm questionnaire, which served as the basis for categorisation. The sociomathematical instrument was developed as 26 statements on a 4-point Likert scale, with indicators: experience of mathematics, explanation of mathematics, mathematical differences, mathematical communication, mathematical effectiveness, and mathematical insight. Before the sociomathematical norm instrument is used, it is tested for validity and reliability.

Sociomathematical norm score questionnaire data obtained were then categorised into three categories of high, medium and low using the following formula, as shown in Table 1 below.

Table 1

Grouping of Sociomathematical Norm Categories

Category	Distribution of Sociomathematical Norm Scores ($\boldsymbol{x}$)
Low	$x < \bar{x} - SD$
Medium	$\bar{x} - SD \leq x \leq \bar{x} + SD$
High	$x > \bar{x} + SD$

Note: x sociomathematical norm scores, $\bar{x}$mean of the sociomathematical norm score, SDstandard deviation of the sociomathematical norm score

The results of the categorisation of 14 respondents, 2 per socio-mathematical norm category (high, medium, and low), are shown in Table 2 below.

Table 2

Categorisation of Students Based on Aspects of Sociomathematical Norm

No	Respondent Code	Score	Category
1	SR-2	56	Low
2	SR-1	64	Low
3	SS-2	79	Medium
4	SS-1	78	Medium
5	ST-2	98	High
6	ST-1	104	High

After determining the categorisation of respondents, as shown in Table 2, 6 respondents, based on the high, medium, and low sociomathematical norm categories, were selected; each group of 2 respondents was given a numeracy skill test. The test consists of 5 items that refer to indicators: explaining mathematical ideas from mathematical situations in writing using real objects or pictures; expressing the context of everyday events in symbols and mathematical models (Fitriana et al., 2022). The instrument for testing numeracy skills was first tested for validity and reliability.

Data Analysis

The data analysis commenced with an examination of the outcomes from the numeracy skill assessment. Observations were conducted on respondents' responses to identify and analyse the obstacles encountered. Furthermore, the results of the analysis were then confirmed through interviews with the respondents to explore and cross-check the data on epistemological obstacles to numeracy skills that occurred, including: conceptual obstacles, procedural obstacles and operational technical obstacles(Maarif et al., 2021). Triangulation was conducted to ensure the acquisition of reliable data for discerning the features of epistemological barriers to students' numeracy skills in accordance with sociomathematical norms.

Results

The outcomes of examining students' or respondents' responses to the numeracy questions revealed several common epistemological obstacles, as illustrated in Table 3 below.

Table 3

Results of Observation of Student Answers to the Numeracy Ability Test

Epistimological Obstacles Type	Obstacle Description	Socimathematical Norm Category					
		High		Medium		Low	
		ST-1	ST-2	SS-1	SS-2	SR-1	SR-2
Conceptual Obstacles	Misunderstanding of the concept of units of length, area and volume	x	x	x	v	v	v
	Do not understand the symbol of congruence on the side of the geometric shape which is interpreted as the concept of congruence in spatial geometry	x	x	x	x	v	v
	Cannot distinguish the surface area and the base area of a geometric shape	x	x	x	v	v	v
	Does not understand the concept of part of a whole volume	x	x	x	x	v	v
Procuderal Obstacles	Lack of understanding of known information so that there are problem solving procedures that are missed	x	x	x	v	v	v
	The procedure for writing the volume symbol in the solution steps has been arranged invisibly, which may affect the meaning of the solution even if the intended answer is correct and thoroughly understood.	x	x	x	x	x	v
	Ignore the unit symbol	x	x	v	v	v	v
	Prosedur penyelesaian tidak terstruktur	x	v	v	v	v	v
	Unstructured answer procedure	v	v	v	v	v	v
Operational Technical Obstacles	There are no significant obstacles in the multiplication and addition operational techniques	v	v	v	v	v	v

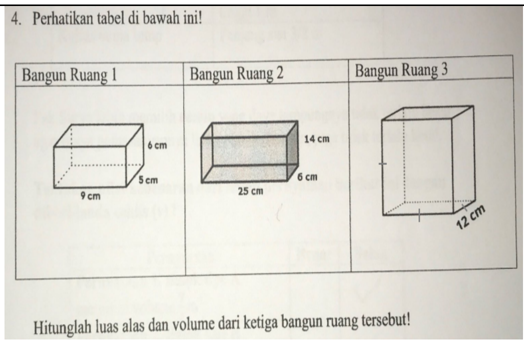
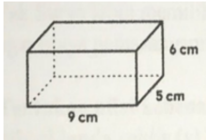
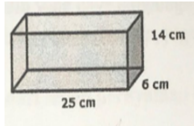
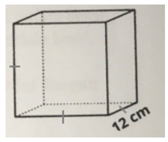
Note: v: found; x: not found

Table 3 presents findings on epistemological barriers from the analysis of the numeracy responses of 6 respondents in the sociomathematical norm category, along with findings on epistemological obstacles. The results of the analysis were then confirmed for each respondent to be explored by the interview process. The results of an in-depth study of students' epistemological obstacles to numeracy skills based on aspects of sociomathematical norms will be explained as follows.

To deepen epistemological understanding of numeration skills, students with low sociomathematical norm category take several numeracy skills questions. One of the questions is shown in Figure 1.

Figure 1

Numeracy Skill Question No. 4

<table>
<tr>
<td>
</td>
<td>Translete figure:
4. Look at the figure below
<table>
<tr><td>Geometric Shapes 1</td><td>Geometric Shapes 2</td><td>Geometric Shapes 3</td></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
</table>
Calculate the base area and volume of the three geometric shapes.</td>
</tr>
</table>

In students with low sociomathematical norms, there are several conceptual obstacles including; misunderstanding of the concept of units of length, area and volume; cannot distinguish the surface area and the base area of a geometric shape; does not understand the symbol "-" on the side of a geometric shape which is interpreted as the concept of congruence in spatial geometry; and do not understand the concept of parts of a whole volume. This can be seen in the answers given by SR-2, which did not indicate any errors in writing the units of length, area, and volume, leading to inaccuracies in the answers. Figure 2 shows the results of SR-2's answers to problem number 4.

Figure 2

RR-2 Answers to Numeracy Skill Question No. 4

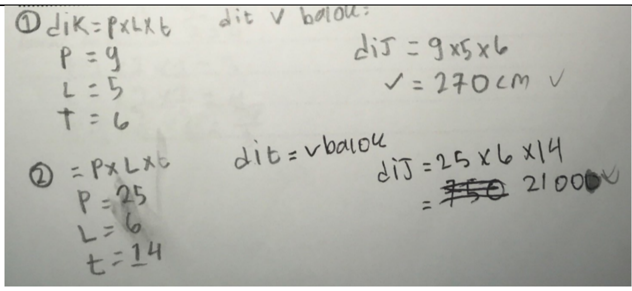
<table>
<tr>
<td>
</td>
<td>Translete figure 2:
1. is known: p x l x t
p = 9
l = 5
t = 6
Asked: block volume
Answer:
V = 9 x 5 x 6
V = 270 cm
2. is known: p x l x t
p = 25
l = 6
t = 14
Asked: block volume
Answer:
V = 25 x 6 x 14
V = 2100</td>
</tr>
</table>

Figure 2 shows that RR-2 does not understand the unit for volume. It can be seen from the results of RR-2's answer that the volume for Figure 1 = 270 cm. This shows RR-2's lack of understanding of volume units. In addition, the answer presented by RR-2 is also incomplete. There are unanswered statements, namely the surface area for geometric shapes number 1 and 2, and questions about geometric shape number 3 are not answered. RR-2 encountered several difficulties, so it could not solve these questions. This can be seen from the excerpts from the interview with RR-2.

P	:	*In question number 4, what is asked?*
RR-2	:	*Eee..this is the volume sir, it's like a cuboid, sir, so we were told to calculate the volume [while pointing at the answer]*
P	:	*Anything else to ask?*
RR-2	:	*Just volume sir*
P	:	*Try reading it carefully again*
RR-2	:	*Volume and area sir*
P	:	*What area?*
RR-2	:	*Hmmm [feeling confused]*
P	:	*Ok, why only volume is searched*
RR-2	:	*I understand that, sir, volume*

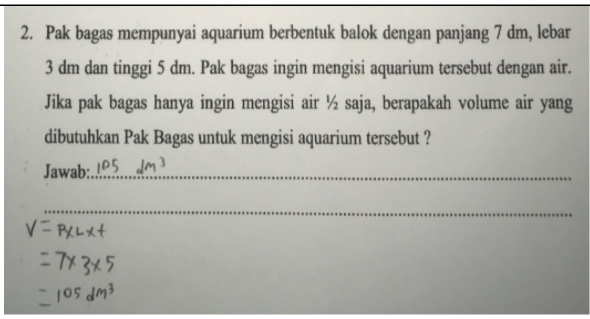
From the interview excerpts, it can be seen that RR-2 did not fully understand the information requested and what was known. RR-2 only knows part of the information asked, namely, the volume. Meanwhile, the area of the base asked in question 4 was not done because they did not understand the concept. Furthermore, the epistemological obstacle that students face is their misunderstanding of the symbol "-" on the side of a geometric shape, which is interpreted as the concept of congruence in solid geometry. In Figure 2, RR-2 does not complete the question for wake number 3. RR-2 had difficulty answering this because the information in the picture shows only width = 12 cm, with no length or height. RR-2 assumes that the third shape in problem 4 is a beam, so to obtain its volume, the element lengths and heights are needed. RR-2 does not understand that a geometric shape is a cube with the symbol "-" on the side as a sign that all sides are equal, so to determine the volume of the shape, you can use the formula $v = s \times s \times s$. These findings were confirmed by interviews with RR-2. The following are excerpts from the interview.

P	:	*All right, so building number 3 isn't done, right?*
RR-2	:	*I don't know sir*
P	:	*Why?*
RR-2	:	*This is it sir [while showing a picture of the geometric shape in the question], in picture 3 there is no length and height.*
P	:	*Oh, I see, what does picture number 3 really look like?*
RR-2	:	*like a cuboid sir*
P	:	*OK, there's a crossed out [sambal shows a "-" sign on the side of the cube], what does this mean?*
RR-2	:	*I don't know sir*

Furthermore, conceptual obstacles that occur in students with students with low sociomathematical norms do not understand the concept of part of a whole volume. This can be seen in the results of RR-1's answers to the numeration ability problem number 2 in Figure 3, as follows.

Figure 3

RR-1 Answers to Numeracy Skill Question No. 2

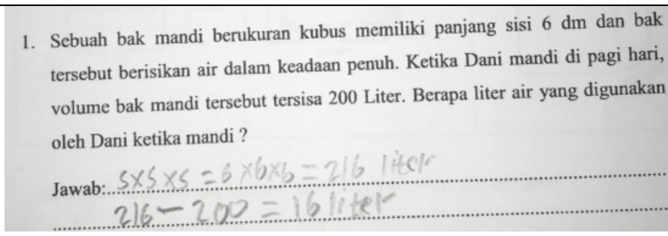
 2. Pak bagas mempunyai aquarium berbentuk balok dengan panjang 7 dm, lebar 3 dm dan tinggi 5 dm. Pak bagas ingin mengisi aquarium tersebut dengan air. Jika pak bagas hanya ingin mengisi air ½ saja, berapakah volume air yang dibutuhkan Pak Bagas untuk mengisi aquarium tersebut ? Jawab: 105 dm³ V = P x L x t = 7 x 3 x 5 = 105 dm³	Translete figure: 2. Bagas has a block-shaped aquarium with a length of 7 dm, a width of 3 dm and a height of 5 dm. Bagas wants to fill the aquarium with water. If Bagas only wants to fill ½ of the water, how much volume does Bagas need to fill the aquarium? Answer: V = p x l x t V = 7 x 3 x 5 V = 105 dm³

In Figure 3, it can be seen that RR-1's answer was incorrect. RR-1 does not understand the concept of parts of a whole. The problem to be tested is: what volume of water is needed if it is only filled to ½ of the tub's volume? From RR-1's answer, the required volume is the total bath volume. Thus, there is a misunderstanding of the concept of part-of-the-whole.

Table 3 shows the epistemological barriers to numeracy skills in procedural barriers in students with low sociomathematical norm categories that occur, namely: a lack of understanding of known information, so that there are problem-solving procedures that are skipped; ignoring the writing the volume symbol; ignoring the writing of unit symbols. This can be seen in RR-1's answers to the numeracy ability problem number 1, as shown in Figure 4 below.

Figure 4

RR-1 Answers to Numeracy Skill Question No. 2

 1. Sebuah bak mandi berukuran kubus memiliki panjang sisi 6 dm dan bak tersebut berisikan air dalam keadaan penuh. Ketika Dani mandi di pagi hari, volume bak mandi tersebut tersisa 200 Liter. Berapa liter air yang digunakan oleh Dani ketika mandi ? Jawab: s x s x s = 6 x 6 x 6 = 216 liter 216 – 200 = 16 liter	Translete figure: 1. A cube-sized bathtub has a side length of 6 dm and the bathtub is full of water. When Dani showered in the morning, the remaining volume of the bathtub was 200 liters. How much water does Dani use when bathing? Answer: s x s x s = 6 x 6 x 6 = 216 liter 216 – 200 = 16 liter

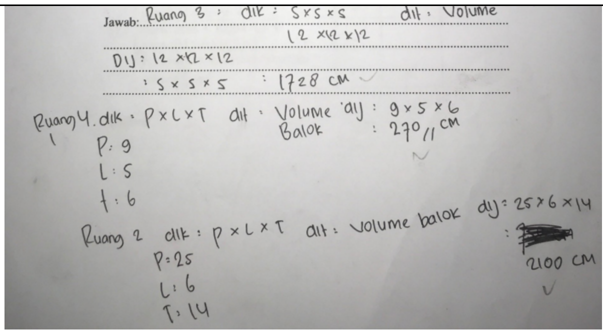
Other procedural obstacles experienced by students with low sociomathematical norms, namely: solving procedures are not structured and do not write down information that is known and asked. Figure 4 shows that RR-1 has no known information and unstructured answers. This is very important to understand the problem to be solved in its overall meaning. The RR-1 also skips the procedure for writing "remaining bath volume = 216 liters – 200 liters = 16 liters. It can be seen that the RR-1 immediately wrote "216-200 = 16 liters". Even though the answer is correct, the settlement procedure must be written in a structured manner so that the logical flow of thinking can be captured clearly. Furthermore, RR-1 also seems not to have written down the known information and the problems asked. It is important to know the problems and ideas of solutions to be written.

The next epistemological obstacle is the operational technique obstacles, which will be analysed in relation to the numeracy skills of elementary school students. Table 3 shows that in general, students with low sociomathematical norms do not experience operational technical difficulties, especially multiplication and division operations. Overall, students in solving numeracy skills do not experience problems in operating multiplication and division in solving solid geometric problems.

Epistemological obstacles to students with medium sociomathematical norm categories, including conceptual, procedural, and operational technique obstacles, were analysed using students' responses to the numeracy skill test. Table 3 shows the conceptual obstacles that occur in students with medium sociomathematical norms, namely a misunderstanding of the concepts of length, area and volume units; and cannot distinguish the surface area and the base area of a geometric shape. This can be seen in the results of RS-2's answers, which experienced errors in the writing area and volume units. Figure 5 shows the results of RS-2's responses to the numeracy ability test question 4 (see Figure 1).

Figure 5

RS-2 Answers to Numeracy Skill Question No. 4

<table>
<tr>
<td>


</td>
<td>
Translete figure:
Answer:
Geometric Shapes 3, is known: s x s x s
: 12 x 12 x 12
Asked: Volume
Answer: 12 x 12 x 12
: 1728 cm
Geometric Shapes 4, is known: p x l x t
p = 9
l = 5
t = 6
Asked: block volume
Answer: 9 x 5 x 6
:270 cm
Geometric Shapes 2, is known: p x l x t
p = 25
l = 6
t = 14
Asked: block volume
Answer: 25 x 6 x 14
:2100 cm
</td>
</tr>
</table>

Figure 5 shows that RS-2 already understands the known information in the numeration problem to be solved. This can be seen by writing down what is known and what will be asked.

However, RS-2 does not write questions about the size of the base area for each geometric shape. Furthermore, RS-2 also experienced an error in writing the volume unit. As shown in Figure 5, RS-2 writes the volume units in cm, not cm2. It seems that RS-2 doesn't understand the difference in writing units for length, area and volume. To explore the results of the analysis of RS-2 answers, in-depth interviews were conducted. The following are excerpts from the interview.

P	:	*OK, let's continue with question number 4, what information is found in the problem?*
RS-2	:	*Here sir, a picture of a cuboid, asked to find the volume*
P	:	*OK, what's the volume?*
RS-2	:	*This is 270 and this one is 2100 [while showing answer no. 4]*
P	:	*Is the unit for length in cm?*
RS-2	:	*Yes sir*
P	:	*As for the volume, isn't it different?*
RS-2	:	*The unit is cm sir*
P	:	*Well, the formula for cuboid volume is length times width times height? The unit for length and width is cm. So what is the volume to the power of the other one?*
RS-2	:	*Hmmm…[confused]*
P	:	*So the unit of volume is cm3, right or not?*
RS-2	:	*I just remembered, sir [while confirming the researcher's question]*
P	:	*Why is it only written cm?*
RS-2	:	*I forgot sir*

Based on the interview results, it appears that RS-2 experienced confusion about volume units. RS-2 was confused because it forgot about volume units. This happened because they were not accustomed to writing down the answers for each unit so they did not experience errors in writing volume units. Thus, the answer proposed by RS-2 is not perfect because the units have different meanings.

P	:	*For the base area question, why isn't it done? try reading the question again*
RS-2	:	*[reading the question] yes, sir, I focus on volume*
P	:	*So why not answer?*
RS-2	:	*Hmm [confused]*
P	:	*It's good if you answer now, how much is the answer?*
RS-2	:	*I don't know sir, I forgot the area of the cuboid*
P	:	*Which is not the area of the cuboid but the area of the base*
RS-2		*[fall silent]*
P	:	*Ok, I'll help you, for picture number 1, what is the length and width?*
RS-2	:	*This is sir 9, this is 5 [while showing picture number 1 in question number 4]*
P	:	*Ok, then what is the area?*
RS-2	:	*9 times 5*

Excerpts from the interview show that RS-2 does not understand the difference between the area of the cuboid base and the total area of the cuboid, so he is confused. RS-2 understood that the area of the base is the area of the entire cuboid and had forgotten the formula. Thus, RS-2 does not write down the answer for the surface area of each geometric shape in question number 4.

Furthermore, procedural obstacles that occur in students with medium sociomathematical norm categories include: a lack of understanding of known information, so that problem-solving procedures are skipped; ignoring the writing of unit symbols; and not writing down known information that is asked for. In general, when answering numeracy questions, students do not write down the information known and what is asked.

This was confirmed by the results of RS-1 students' responses to the numeracy skill test number 3, as shown in Figure 6 below.

Figure 6

RS-1 Answers to Numeracy Skill Question No. 4

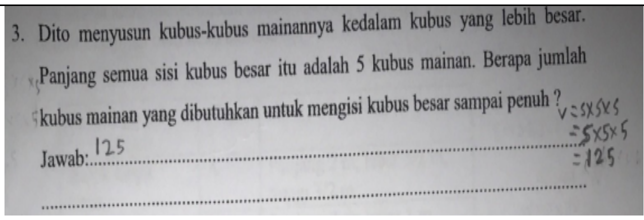
<table>
<tr>
<td>
3. Dito menyusun kubus-kubus mainannya kedalam kubus yang lebih besar. Panjang semua sisi kubus besar itu adalah 5 kubus mainan. Berapa jumlah kubus mainan yang dibutuhkan untuk mengisi kubus besar sampai penuh ? v = s x s x s
= 5 x 5 x 5
Jawab: 125 = 125</td>
<td>Translete figure:
3. Dito Arranged his toy cubes into larger cubes. The length of all sides of the large cube is 5 toy cubes. How many toy cubes are needed to fill the large cube completely?
Answer: 125
V = s x s x s
= 5 x 5 x 5
= 125</td>
</tr>
</table>

Figure 6 shows that RS-1 does not record the known and requested information, even though the submitted answers are correct. In addition, the answer proposed by RS-1 is less structured by direct writing $v = s \times s \times s = 5 \times 5 \times 5 = 125$. RS-1 should write down information on how the volume of the small cube compares to the volume of the large cube. The answer also does not say that 125 is the number of small cubes that cover the entire space of the big cube. In addition, RS-1 does not write down the unit symbol, even though in problem 3, the unit is a length. However, to solve the problem, it should be written down by writing "volume units" so that you can distinguish between the volume of a small cube and the volume of a large cube.

In the operational technique, the numeracy skills of elementary school students in the medium sociomathematical norm category are not encountering any problems. Overall, students in solving numeracy skills do not experience problems in operating multiplication and division when solving geometry problems.

To deepen students' epistemological obstacles to numeracy abilities based on the high sociomathematical norm category, students are asked several questions. In general, students in the high sociomathematical norm category did not find conceptual obstacles. This can be seen in the answers submitted by RT-1 to the number questions, as shown in Figure 7 below.

Figure 7

RT-1 Answers to Numeracy Skill Question No. 2

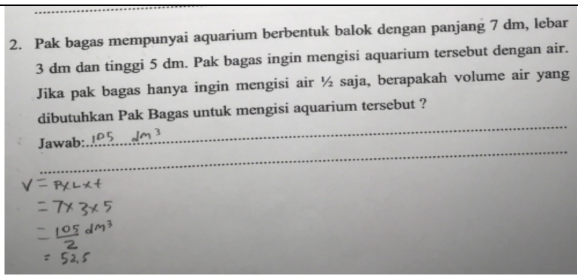
 2. Pak bagas mempunyai aquarium berbentuk balok dengan panjang 7 dm, lebar 3 dm dan tinggi 5 dm. Pak bagas ingin mengisi aquarium tersebut dengan air. Jika pak bagas hanya ingin mengisi air ½ saja, berapakah volume air yang dibutuhkan Pak Bagas untuk mengisi aquarium tersebut ? Jawab: 105 dm³ V = p×l×t = 7×3×5 = 105/2 dm³ = 52,5	Translete figure 7: 2. Bagas has a block-shaped aquarium with a length of 7 dm, a width of 3 dm and a height of 5 dm. Bagas wants to fill the aquarium with water. If Bagas only wants to fill ½ of the water, how much volume does Bagas need to fill the aquarium? Answer: V = p x l x t V = 7 x 3 x 5 V = 105/2 dm^3 = 52.5

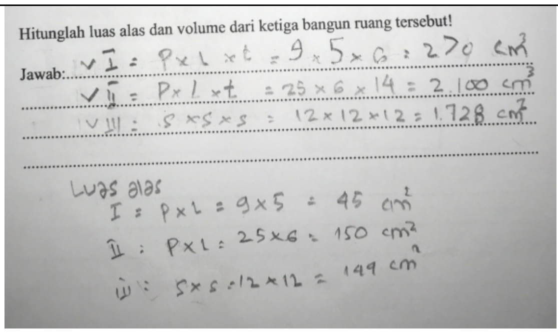
Figure 7 shows that RT-1 had no problems in solving the numeration problem number 2. It can be seen in the sequence of answers submitted by RT-1, including the volume unit. There are no errors in the writing of answers or formulas. Thus, a thorough understanding of the problem to be solved and the concepts required to solve it is required. This was reinforced by the results of interviews with RT-1, as well as excerpts from the interviews.

P	:	*OK, try to explain the answer to question no. 3?*
RT-1	:	*[shows prepared answers] So this is what volume is looking for but half sir*
P	:	*OK, why?*
RT-1	:	*Because there is half of the bath*
P	:	*Ok, please continue your explanation*
RT-1	:	*Volume equals* $p \times l \times t$ *jadi* $7 \times 3 \times 5 = 105$. *but because half of it is divided by 2 the result is 52.5 sir*

Table 3 shows the procedural barriers to students' numeracy skills in the high sociomathematical norm category who do not write down information that is known and asked. However, these obstacles do not directly affect the correctness of the answers. This can be seen from the results of RT-2's answers to the numeration question number 4 (shown in Figure 1), as shown in Figure 8 below.

Figure 8

RT-1 Answers to Numeracy Skill Question No. 4


Hitunglah luas alas dan volume dari ketiga bangun ruang tersebut!

Jawab: V I = P x L x t = 9 x 5 x 6 = 270 cm³

V II = P x l x t = 25 x 6 x 14 = 2.100 cm³

V III : s x s x s = 12 x 12 x 12 = 1.728 cm³

Luas alas

I = P x L = 9 x 5 = 45 cm²

II : P x L = 25 x 6 = 150 cm²

III : s x s = 12 x 12 = 144 cm²

Translete figure:

Calculate the base area and volume of the three geometric shapes.

Answer:

V I = p x l x t = 9 x 5 x 6 = 270 Cm^2

V II = p x l x t = 25 x 6 x 14 = 2100 Cm^2

V 1 = p x l x t = 12 x 12 x 12 = 1728 Cm^2

Base area

I = p x l = 9 x 5 = 45 Cm^2

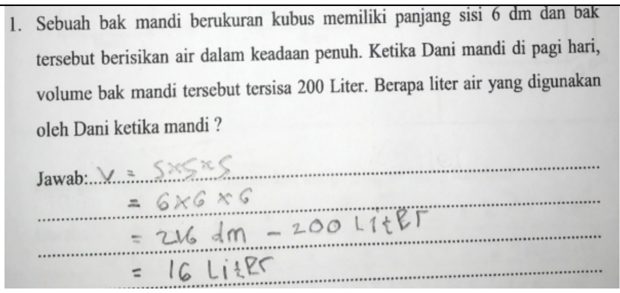
II = p x l = 25 x 6 = 150 Cm^2

III = s x s = 12 x 12 = 144 Cm^2

Figure 8 shows the correct answers from RT-1, but the known and asked information is not written down. Even if the answer is correct, it is important to record the answer procedurally. Thus, the student's understanding of the problem is presented comprehensively. Furthermore, procedural obstacles that occur in students with high sociomathematical norm categories are unstructured completion procedures. This was confirmed by RT-1's answers, as shown in Figure 9.

Figure 9

RT-2 Answers to Numeracy Skill Question No. 1


1. Sebuah bak mandi berukuran kubus memiliki panjang sisi 6 dm dan bak tersebut berisikan air dalam keadaan penuh. Ketika Dani mandi di pagi hari, volume bak mandi tersebut tersisa 200 Liter. Berapa liter air yang digunakan oleh Dani ketika mandi ?

Jawab: V = SxSxS

= 6x6x6

= 216 dm – 200 Liter

= 16 Liter

Translete figure:

1. A cube-sized bathtub has a side length of 6 dm and the bathtub is full of water. When Dani showered in the morning, the remaining volume of the bathtub was 200 liters. How much water does Dani use when bathing?

   Answer: V = s x s x s

   = 6 x 6 x 6

   =216 dm – 200 liter

   = 16 liter

Figure 9 shows that RT-2 also skipped the procedure of writing "remaining tub volume = 216 litres – 200 liters = 16 liters. It can be seen that RT-2 immediately wrote "216 dm - 200 litres = 16 liters". Even though the answer is correct, the procedure must be written in a structured manner so that the logical flow of thinking can be clearly captured. Furthermore, RT-2 was also seen not writing down the known information and the problems asked. It is important to know the problems and ideas of solutions to be written.

Table 3 shows that, in general, students in the high sociomathematical norms category do not encounter operational technical obstacles, especially with multiplication and division. Overall, students in solving numeracy skills do not experience problems in operating multiplication and division when solving geometric problems.

Discussion

Numeracy skills are a basic competency in studying mathematics and a determinant of success in performing mathematical calculations (Seitz & Weinert, 2022). The importance of numeracy skills in learning mathematics, especially in elementary schools, is the basis for continuing studies on the factors that influence them. One aspect of studying numeracy skills is the epistemological obstacles, including conceptual, operational, and technical obstacles (Hariyani, Herman, Suryadi, & Prabawanto, 2022). To identify epistemological obstacles to numeracy skills, a categorical variable is needed to map them specifically. A categorical variable within the affective domain is the sociomathematical norm, which has the potential to boost students' confidence during collaborative mathematics learning sessions, thus positively influencing the development of their mathematical thinking abilities (Maarif & Fitriani, 2023).

The analysis results indicate that students categorised as low in socio-mathematical norms exhibit conceptual barriers, including misconceptions regarding length, area, and volume units, difficulty distinguishing the surface area and base of geometric shapes, a lack of understanding of congruence symbols in geometric shapes, and struggles with the concept of volume fractions. Similarly, students with medium socio-mathematical norms also face conceptual challenges, such as misunderstanding unit concepts for length, area, and volume and struggling with volume fraction comprehension. Conversely, students categorised with high socio-mathematical norms showed no significant conceptual obstacles. These obstacles are generally caused by students' lack of understanding of the symbols used to solve numeration problems. The findings emphasise the critical importance of using mathematical symbols accurately, as errors in their application can have serious consequences, given their role in guiding problem-solving strategies. Similarly, Alawiyah et al., (2018) it reveals the importance of understanding the use of mathematical symbols, which can shape students' habits to assist the process of problem-solving analysis.

Furthermore, the conceptual barrier that occurs in students with the low sociomathematical norm category is a lack of understanding of the concept of partiality of the whole. This concept is a basic concept in studying mathematics, especially geometry, which is a postulate of Euclid (Michael, Gagatsis, & Gagatsis, 2013). This underscores the importance of grasping geometric concepts in mathematics education. This is in line with the words that Sarasvuo et al., (2022) suggest that a strong understanding of mathematical concepts is pivotal for facilitating future advancements in mathematical learning.

Procedural obstacles that occur in the low sociomathematical norm category include: lack of understanding of known information, so that problem-solving procedures are skipped; procedure for writing volume symbols; ignoring the writing of unit symbols; unstructured settlement procedures; failure to document requested information. For students with medium sociomathematical norm categories, the following procedural obstacles occurred: failure to write volume symbols, ignoring unit symbols, unstructured settlement procedures, and failure to document requested information. Meanwhile, procedural obstacles for students with high sociomathematical norm categories include: procedures for writing volume symbols; ignoring the writing of unit symbols; and unstructured settlement procedures; failing to document requested information.

The procedure for solving numerical problems will not be a problem if students know the information. Students will start the settlement procedure if they understand what information is in the problem and what information is asked for. This aligns with the findings of Maarif et al.,(2019), who highlighted the importance of accurately documenting known internal information, such as symbols, numbers, or theorem summaries, as it aids systematic analysis of the problem-solving steps in geometry. In addition, the study uncovered that a common epistemological hurdle in mathematics problem-solving is when students fail to grasp information they already know and neglect to record it, leading to forgetting important theorems relevant to the problem at hand.

The results of the study also revealed that other procedural obstacles generally experienced by students in the low, medium, and high sociomathematical norm categories included ignoring the writing of unit symbols. Writing symbols in mathematics is an important part of solving problems. Mathematical symbols have meaning; if there is an error in writing the symbol, it will result in an error in understanding the concept of the problem to be solved (Sukri, Prabawanto, & Usdiyana, 2023). The results of research reveal that, to overcome some of the obstacles to learning mathematics, it is necessary, in a lesson, to emphasise the understanding of semantic and symbolic meanings so that students can communicate their ideas when solving problems. In addition, the research results Jupri & Sispiyati, (2021) concluded that sensitivity to symbols enables students to recognise and examine the need for appropriate problem-solving steps.

Subsequently, the analysis findings indicate that students across low, medium, and high socio-mathematical norm categories do not encounter significant operational technical hurdles. This is evident, as the numeracy problems presented involve only addition and multiplication. This suggests that students exhibit proficiency in utilising these basic operational techniques, which is crucial for developing mathematical numeracy skills. These results are consistent with a study that found that elementary school students face no difficulties with multiplication and addition operations when solving fraction problems.

Understanding the intricate relationship between numeracy skill development and sociomathematical norms is essential for educators and school administrators. Recognising the impact of sociomathematical norms on students' mathematical understanding allows for the implementation of more targeted and culturally responsive teaching strategies. By acknowledging and addressing the sociocultural factors that influence students' comprehension and application of numeracy skills, educators can create inclusive learning environments that cater to students' diverse backgrounds. Additionally, bridging the research gap in this area provides practical insights for designing effective pedagogical approaches tailored to mitigate epistemological obstacles arising from sociomathematical influences. This proactive approach not only enhances numeracy skills but also fosters equitable learning outcomes for elementary school students, ultimately contributing to their academic success and overall well-being. Therefore, incorporating sociomathematical norms into managerial decisions and educational practices can significantly impact the effectiveness and inclusivity of mathematical education in elementary schools.

The absence of significant operational technical obstacles in multiplication and addition techniques indicates a certain level of procedural fluency in these basic operations. Yet, it underscores the necessity of reinforcing foundational skills. This presents an opportunity for educators to leverage existing strengths while addressing conceptual and procedural challenges in more complex mathematical domains (Reusser, 2000). The call for targeted instructional interventions underscores the need for tailored approaches to tackle each obstacle effectively, urging educators to employ diverse teaching strategies such as real-world applications, visual aids, and interactive activities to enhance conceptual understanding. Simultaneously, providing ample opportunities for practice and reinforcement can bolster procedural fluency, ensuring a well-rounded mathematical proficiency (Alam & Mohanty, 2023). In conclusion, this theoretical contribution advocates for a nuanced understanding of epistemological obstacles in mathematical learning, framed within the Socimathematical Norm Categories. By recognising the interplay between social and mathematical norms, educators can craft interventions that bridge conceptual gaps and enhance procedural fluency, ultimately fostering a comprehensive and robust mathematical foundation among students.

The results of this study indicate that in developing mathematical numeracy skills in elementary school students, there are, of course, obstacles. Therefore, the research results can serve as a reference for determining learning treatments based on findings about numeracy ability barriers. In addition, when developing numeracy skills, it is necessary to pay attention to affective aspects, especially socio-mathematical norms, to support students’ mathematics learning. Thus, learning obstacles that arise can be minimised, helping students' understanding of numeracy skills. In addition, it is recommended that further research be carried out using other methodologies to enable generalisation. In addition, research on epistemological barriers to numeracy skills can be applied to other mathematics subjects and at the junior and senior secondary levels.

Conclusions

This study examines various epistemological obstacles encountered by students across different sociomathematical norm categories, offering valuable insights into their numeracy abilities. For students with low sociomathematical norms, conceptual obstacles, such as misunderstandings of length, area, and volume units, as well as procedural challenges, such as skipping known information, were evident. These obstacles were further exemplified through students' responses to numeracy questions, highlighting the importance of addressing fundamental conceptual understanding and structured problem-solving approaches. Moreover, students in the medium sociomathematical norm category faced similar conceptual and procedural barriers, underscoring the need for targeted interventions to enhance comprehension and methodical reasoning skills. Conversely, students with high sociomathematical norms displayed proficiency in conceptual understanding and problem-solving procedures, albeit with occasional lapses in structured completion processes. These findings underscore the importance of integrating sociomathematical norms into pedagogical practices to deepen understanding of mathematical concepts and foster effective problem-solving strategies. Additionally, while operational technical obstacles were minimal across all sociomathematical norm categories, the comprehensive analysis of epistemological barriers offers valuable insights to inform instructional approaches tailored to students' diverse learning needs.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication or conduct of this research titled:"Numeracy Skill in Learning Mathematics for Elementary School Students: How Sociomathematical Norm Becomes a Category in the Characteristics of Epistemological Obstacles." This research was conducted independently and is free from any commercial, financial, or personal relationships that could be construed as a potential conflict of interest. The authors have no affiliations or involvement with any organisation or entity that has a financial interest or non-financial interest in the subject matter or materials discussed in this study. All ethical considerations in the collection and analysis of data have been duly observed, and the research was carried out solely for academic and scientific purposes.

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