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An Analysis of Students' Mathematical Problem-Solving Ability at Class VII Social Arithmetic Materials Based on Learning Styles

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Abstract

Learning style is an activity of thinking, processing, and understanding something that is preferred and has the characteristics of each person. Moreover, problem-solving ability is a skill that needs to be possessed in the process of solving mathematical problems. This study aims to describe students' problem-solving abilities on social arithmetic material in terms of learning styles. The research was conducted through a descriptive qualitative research design. The subject population was all seventh-grade students of MTs Al-Khairiyah, South Jakarta. Sampling was conducted using a total sampling technique. Three students were selected, namely students who scored the highest visual, auditory, and kinesthetic learning styles. The instrument used a learning style questionnaire and a test of problem-solving skills and semi-structured interviews—data analysis techniques with data reduction, exposure, and concluding to explain mathematical problem-solving abilities. The findings of this study were that students with the highest scores of visual, auditory, and kinesthetic learning styles can solve social arithmetic problems based on Polya's steps without any significant differences. They only have different styles when solving problems.

Keywords: problem-solving ability, learning style

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INTRODUCTION

As technology develops, the focus of mathematics education gradually changes from learning achievement to increasing various abilities (Tan & Ang, 2016; Umam & Kowiyah, 2018). An assessment score indicates learning achievement. Nonetheless, the process in learning to seeks improvement in abilities, including communication, problem-solving, critical, and creative thinking is considered more important (Sanders, 2016; Umam, 2018). In line with the view, National Council of Teachers of Mathematics (NCTM) sets five standards for learning mathematics: problem-solving, reasoning, connection, communication, and representation (Dahar, 2011; NCTM, 2000).

Problem-solving skills trigger students to think systematically, logically, critically, and never give up on problems. In this case, mathematics is part of a tool to train students to be proficient in solving problems and building thinking processes. In problem-solving, a person performs analysis, prediction, reasoning, evaluation, and reflection (Anderson, 2009; Phonapichat et al., 2014). Schools' mathematics curriculum views problem-solving as the main activity, as contained in the 2013 curriculum (Kurniasih & Sani, 2014; Warli, 2014). Various aspects have been prepared in K 13, which was developed to prepare generations with characters. Planning and selection of appropriate learning methods are

efforts to be made in the training of problem-solving ability; a specification that is essential in achieving the purpose of the learning process (Cahyani & Setyawati, 2016; Soebagyo, 2018; Wahyudin, 2008). Problem-solving is related to discovery, using logic, inductive and deductive discovery processes, as well as making decisions with a specific purpose (Alexander, 2012; Lakatos, 1976; Polya, 1978; Simon, 1991).

In the learning process, a teacher should have basic knowledge about the learning styles of the students. Gunawan (2007) explains that the students' learning style is how the students do the thinking, process, and understanding of the information obtained (Syofyan, 2017; Syukur & Misu, 2014). Each student has a different learning style. In the case of learning mathematics, there are students who find mathematics easy to understand and some find it difficult to understand. Some students like it when the teachers teach by writing, conveying orally or like small group learning for discussion. There are even students who wish when the teacher uses props. This situation shows the diversity of learning styles possessed by students. The Neuro-Linguistic Programming expert explained three human learning styles: visual, auditory, and kinesthetic (Lestari et al., 2017; Wikanengsih, 2012). Visual learning style dominates in visual acuity, and it is easier or faster to understand by seeing. The auditory learning style relies more on hearing in understanding and remembering. This learning style likes to talk, discuss or explain. At the same time, the aesthetic learning style is learning by moving, touching, or working.

Someone can experience their learning style when they feel comfortable, safe, and easy to understand when learning. A person chooses a learning style according to him/herself in obtaining information and knowledge in the learning process. Learning style is a consistent way, a habit that a person does to reveal information, experiences for thinking, remembering, and solving problems in learning (Nasution, 2011; Sundayana, 2018). Learning styles are essential to make the learning process fun and to get satisfactory results because individuals will feel comfortable carrying out learning activities.

Gunawan said that students who use a dominant learning style in studying, taking tests would get higher scores than students who study not in accordance with their learning style (Mustafida, 2013; Prianto, 2013). Meanwhile, DePorter and Hernacki stated that the learning style combines students' ways of processing, absorbing, and organizing information, (Mufidah, 2017; Wassahua, 2016). Besides Fleming & Mills, learning style is the tendency of students to use strategies in learning (Minarti, 2013; Seyal & Rahman, 2015).

The views of Neuro-Linguistic Programming explain that there are three human learning styles, namely visual, auditory and kinesthetic (Lestari et al., 2017). Visual learning style dominates in visual acuity, and it is easier or faster to understand by seeing. The auditory learning style relies more on hearing in understanding and remembering. This learning style likes to talk, discuss or explain. In contrast, the aesthetic learning style is learning by moving, touching, or working.

PRISE research in Indonesia released a study that stated that the ability to solve simple math problems was almost the same between new students entering elementary school and those who had graduated from high school (Okenews, 2018). Additionally, research related to difficulties of students in solving mathematical problems have been carried out. Among them include student difficulties in solving the problem of multiple interpretations of the given problem, the lack of prior knowledge, and the lack of mathematical literacy (Buschman, 2020; Wang, 2003). In addition, the lack of knowledge and understanding of students when performing arithmetic operations, whereby students who have low abilities will perform arithmetic operations randomly without knowing the correct procedures (Sutrisno, 2015; Zhang et al., 2014).

The importance of problem-solving in learning mathematics to gain experience from using knowledge and skills in solving complex problems is crucial. Solving math

problems involves using prior knowledge to solve new situations (Mulyati, 2016; Yarmayani, 2016). An overview of problem-solving as the primary process when learning mathematics occurs in the classroom (Umam, 2018; Winarti et al., 2019). Problem-solving is a focused thought to determine the solution to a specific problem (Mawaddah & Anisah, 2015). In line with that, Gunantara argues that problem-solving includes the skills or potential of students to solve the problems and apply them in everyday life (Gunantara, 2014).

Polya (1973) explains the stages to solve problems include: 1) Understanding the problem, 2) Planning a strategy, 3) Implementing the plan, and 4) Re-examining (Luluk, 2019; Netriwati, 2016). The ability to understand the problem can be seen by mentioning what is known, asked, and the conditions given in a problem. Afterwards, it is important to see the relationship between the information obtained with previous knowledge or experience as evidenced by completing the steps. After understanding the problem and developing a plan, then the plan is then carried out. The last step is to re-examine the results so that it can find results as expected. Each student has differences in carrying out the problem-solving process depending on the level of mathematical reasoning they have (Joko S, 2021). This situation happens because of differences in intelligence, thinking skills, creativity, interests, attitudes, and cognitive styles.

The researchers' initial observations to several students at MTs in Jakarta found answers regarding social arithmetic materials. In solving problems, some students have not been systematic, some solve the problems well, and some solve with Polya's steps. Indicators in problem-solving are understanding the problem, formulating a plan, implementing the project, and checking again. In the previous research, we found that the four phases of Polya in solving linear story questions, based on student beliefs, have a different level (Soebagyo et al., 2021). It makes it more interesting for us to know in another way.

Based on the previous explanation, by knowing the learning style, the teacher can maximize mathematical learning, especially problem-solving. Therefore, in this research, the profiles of students' mathematical solving ability on social arithmetic material will be examined in terms of students' learning styles.

METHODS

The type of research used is descriptive to describe students' problem-solving abilities on social arithmetic material regarding learning styles. Students were first divided into two groups based on visual and auditory learning styles, then given social arithmetic questions containing stories to find out the problem-solving profile of each group. The results of the students' answers were analyzed according to the indicators of problem-solving ability.

Subject Selection

The population in this study were all seventh-grade students at MTs Al-Khairiyah Mampang Prapatan Jakarta 2020/2021. The number of students was 131 consisting of 4 classes. The sample selection was the total sampling technique (see table 1). In comparison, the subjects in this study were two students, one student with a visual learning style and one student with an auditory learning style who had the highest score.

Table 1. Sample Demographics

Category		Sum
Gender	Boy	58
	Girl	73
Learning Style	Visual	65
	Auditory	66
Learn Maths during a pandemic with	Mobile	94
	Laptop	37

Data were collected through preliminary observations, learning style questionnaires and problem-solving ability tests, and structured interviews. The learning style questionnaire was conducted to obtain student data on learning styles. The problem ability test was given to students who have visual and auditory learning styles with the highest scores using questions to three students of class VII-C. From the results of students' work, answers to the questions given were obtained. Questions and answers as research data were then analyzed based on problem-solving ability indicators, namely 1) Understanding the problem, 2) Planning, 3) Implementing planning, and 4) Re-examining (see table 2). From the results of data analysis, the profiles of students' problem-solving abilities were described.

Table 2. Problem Solving Indicators According to Polya (Polya, 1978)

Indicators	Criteria for Knowledge Construction Activities
Understanding Problems	Students can identify problems by showing what is known, asked, and the completeness of the elements needed
Devise a Plan	Students can determine the formula or initial method of completion, can conduct investigations for problem-solving
Carrying out a Plan	Students carry out the plan by completing the planned steps
Looking Back	Students re-examine the results of the completion to ensure the work steps are following the procedure

The data obtained were about learning styles and mathematical problem-solving abilities which require valid instruments. The researcher was the main instrument, who was assisted by three other tools: a learning style questionnaire, a social arithmetic test, and an interview guide. The learning style questionnaire was adopted from Bobby Deporter, Mark Reardon, & Srah Singer-Nourie to determine students' learning styles. The test of mathematical problem-solving ability is a matter of social arithmetic material in-story questions.

> Traders bought 630 oranges. Then he sold 315 oranges for Rp. 2.300,-/fruit, another 200 oranges for Rp. 2.800,-/fruit and the rest are not sold because they are rotten. If the trader earns a profit of Rp. 276.500,-, how much is the price to buy one orange!

The data in this study was to classify students' learning styles and problem-solving abilities. The resulting data was then analyzed qualitatively using the stages of reduction, presentation, and conclusion drawing to determine the profile of students' mathematical problem-solving skills (Miles, M. B., & Huberman, 1994)

RESULTS & DISCUSSION

Results

Student Learning Style

The results of the learning style questionnaire data can be seen in the table below:

Table 3. Learning Style Questionnaire Results

Learning Style	Frequency	Percentage
Visual	67	51.1%
Auditory	45	34.4%
Kinesthetic	19	14.5%
Sum	131	100%

S1 Troubleshooting Process with Visual Learning Style

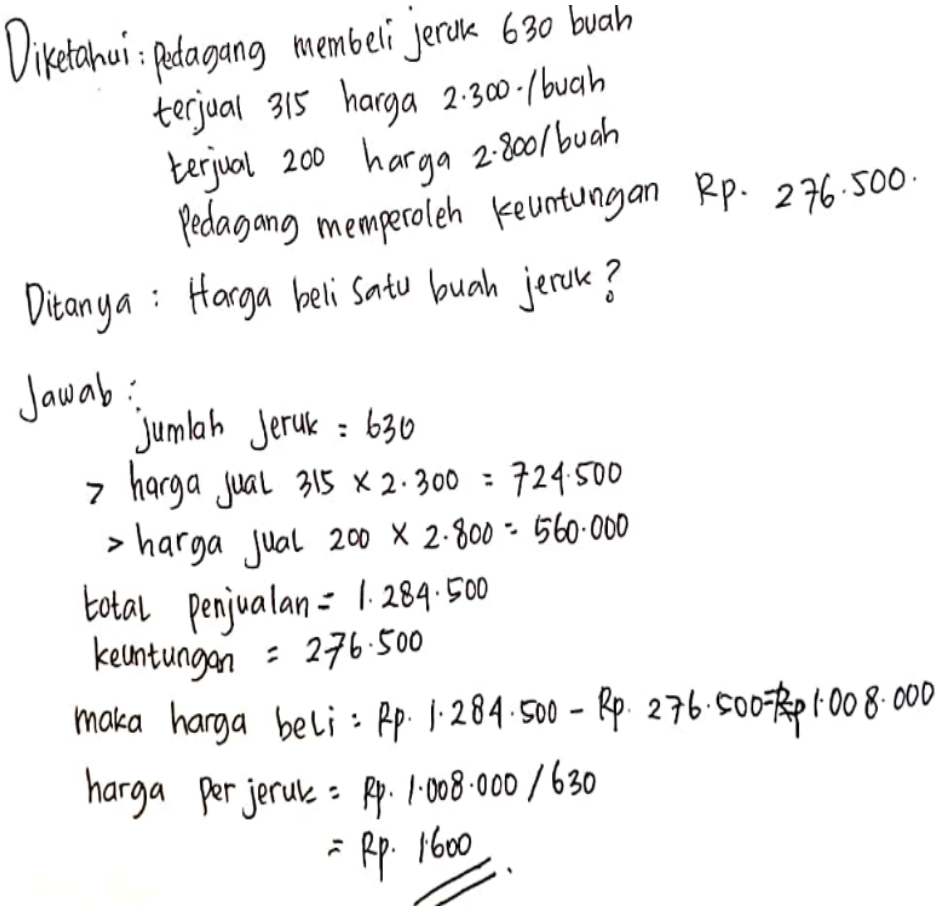


Figure 1. S1 Troubleshooting Process

S2 Troubleshooting Process with Auditory Learning Style

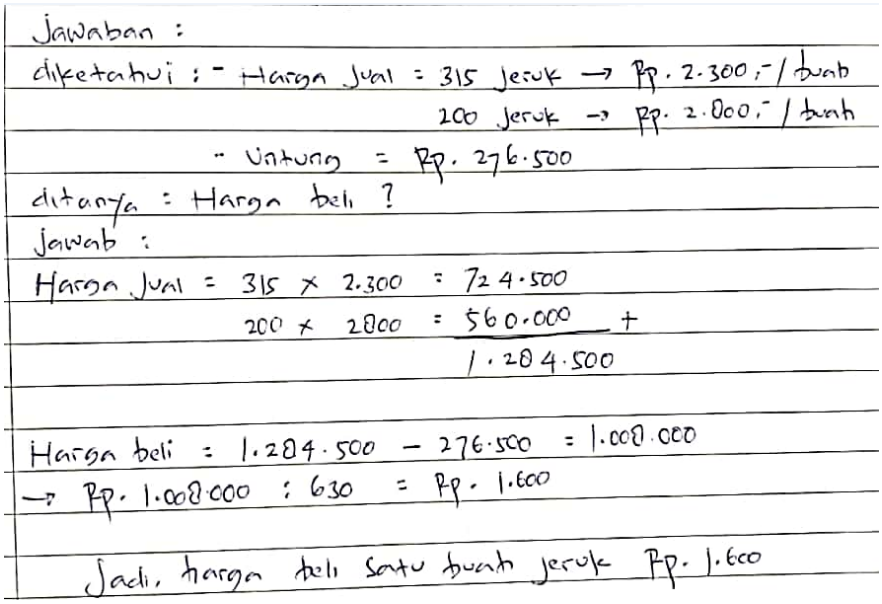
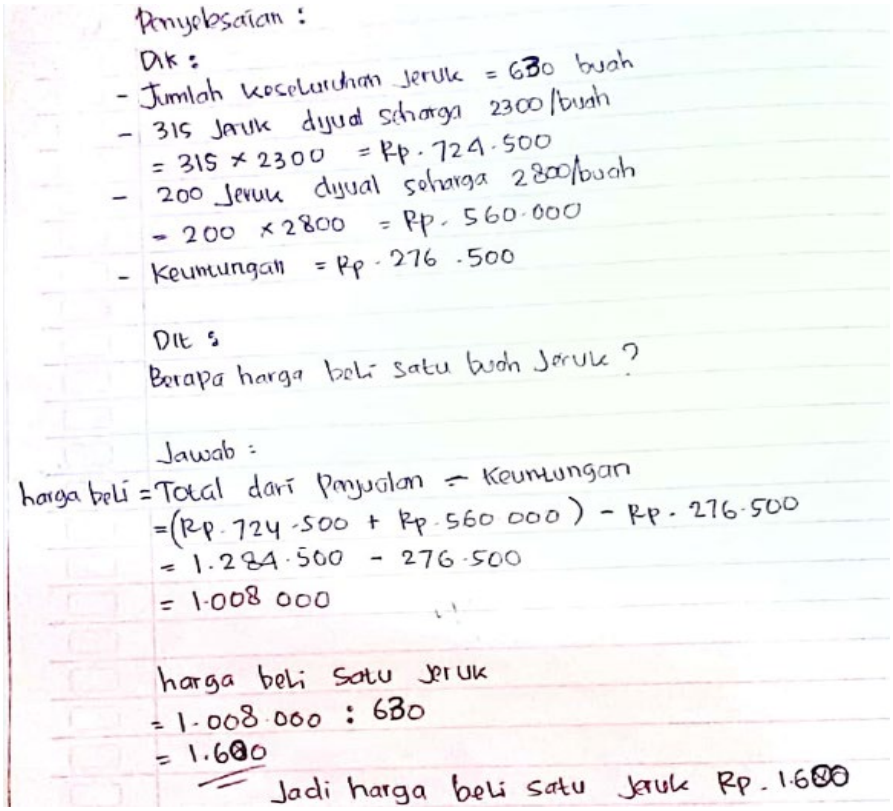

Jawaban :
diketahui : - Harga Jual : 315 jeruk → Rp. 2.300,-/buah
200 jeruk → Rp. 2.800,-/buah
- untung = Rp. 276.500
ditanya : Harga beli ?
Jawab :
Harga Jual = 315 × 2.300 = 724.500
200 × 2800 = 560.000 +
1.284.500
Harga beli : 1.284.500 − 276.500 = 1.008.000
→ Rp. 1.008.000 : 630 = Rp. 1.600
Jadi, harga beli satu buah jeruk Rp. 1.600

Figure 2. S2 Troubleshooting Process

S3 Troubleshooting Process with Auditory Learning Style


Penyelesaian :
Dik :
- Jumlah keseluruhan jeruk = 630 buah
- 315 jeruk dijual seharga 2300/buah
= 315 × 2300 = Rp. 724.500
- 200 jeruk dijual seharga 2800/buah
= 200 × 2800 = Rp. 560.000
- Keuntungan = Rp. 276.500

Dit :
Berapa harga beli satu buah jeruk ?

Jawab :
harga beli = Total dari penjualan − Keuntungan
= (Rp. 724.500 + Rp. 560.000) − Rp. 276.500
= 1.284.500 − 276.500
= 1.008.000

harga beli satu jeruk
= 1.008.000 : 630
= 1.600
Jadi harga beli satu jeruk Rp. 1.600

Figure 3. S3 Troubleshooting Process

Discussion

Based on Table 3, of 131 students, 67 students (51.1%) have visual learning style, 45 students (34.4%) have auditory learning style, and 19 students (14.5%) have kinesthetic learning style. The results of observations and interviews of researchers with several students who have visual learning styles showed similarities to the Mufidah and Wassahua's research results, discovered states that they tend to prefer when the teacher or friend is explaining; In addition, they tend to like to argue or tell stories about the materials being studied (Mufidah, 2017; Wassahua, 2016).

Profile of Math Problem Solving Ability Visual Learning Style

Based on S1's answer and the validity check, interviews were conducted. Below are excerpts of an interview with S1.

R: When you first saw the question, what did you think? (P01)
S1: The question about social arithmetic in the buying and selling section, Ms. (S101)
R: What do you understand from this question? (P02)
S1: There is a selling price of oranges, whereby 315 oranges cost IDR 2,300. Another 200 oranges for IDR 2,800. The number of oranges bought by the seller is 630, meaning that rotten ones are not sold. In addition, the seller's profit is known. What you are looking for is the purchase price of one orange (S102)
R: Okay then, what steps did you take? (P03)
S1: First, I counted the sales of 315 oranges, then the sales of 200 oranges. From there we know the total sales. If you ask the purchase price, then the selling price - profit (S103)
R: Quite detailed in explaining the steps. If you have finished working, do you re-correct the work? (P04)
S1: Of course ma'am, moreover, this number is not pretty hehe (S104)

Based on the results of problem-solving and interviews with S1, it appeared that S1 could solve problems well. S1 explained the information from the questions given accurately and adequately, namely known and asked (S102), making plans in solving problems according to procedures (S103), and re-examining the work results (S104). S1 could carry out four stages of problem-solving according to Polya. In this case, S1 can be classified as a student with high mathematical problem-solving abilities (Fatmawati & Murtafiah, 2018; Samo, 2017; Sari, 2017; Sumartini, 2016).

Profile of Math Problem Solving Ability Auditory Learning Style

Based on the answers of S2 and the validity check of the data, the researchers conducted interviews with S2. Below are excerpts of an interview with S2.

R: When you first saw the question, what did you think? (P01)
S2: Looking for the purchase price of one orange, this is about social arithmetic, ma'am. (S201)
R: What do you understand from this question? (P02)
S2: From the question, it is known that the number of oranges purchased was 600, then 315 were sold for IDR 2,300/fruit, 200 oranges were sold for IDR

2,800/fruit. The rest doesn't count as sold because it's rotten. The advantage of the question is already known, so to find the purchase price, use the formula for selling price less profit (S202)

R: What are you planning to do to solve this problem? (P03)

S2: First, calculate the selling price, which consists of 315 oranges and 200 oranges. Then look for the purchase price = selling price - profit (S203)

R: Quite detailed in explaining the steps. If you have finished working, do you re-correct the work? (P04)

S2: Trying to be thorough, but I still corrected the results that have been done, Mrs. (S204)

Based on the results of problem-solving answers and interviews with S2, it appeared that S2 could solve the problems well. S2 could explain information from the questions appropriately given and accurately, that is, known and asked (S202), making plans in solving problems according to procedures (S203), and re-examining the results of work that was not carried out by S2 (S204). S2 can do the problem-solving stage, according to Polya. S2 can be classified as a student with good mathematical problem-solving skills (Irianti, 2020; Mairing et al., 2011; Rani & Istiqomah, 2019; Risani & Nuriyatin, 2021).

Profile of Math Problem Solving Ability Kinesthetic Learning Style

Based on the answer S3 and the validity check, the researchers conducted interviews with S3. Below are excerpts of an interview with S3.

R: When you first saw the question, what did you think? (P01)

S3: About Social Arithmetic Mrs. (S301)

R: What do you understand from this question? (P02)

S3: It is known that the selling price of oranges is different, namely IDR 2,300/fruit and IDR 2,800/fruit. In addition, the profit from the sale is known. What is being asked is the purchase price of each orange, Mrs. (S302)

R: So, from the information on the questions, what are your plans to solve the problem? (P04)

S3: First, calculate the selling price of 315 oranges, then 200 oranges. Then the total sales - profits are then divided by 630 for the price of each fruit. (S304)

R: Oh, that's right, if you have finished working on it, will your work be corrected again? Why is something crossed out of the previous answer? (P05)

S3: God willing, I always correct ma'am, so why do I cross out something? Because at first, I miscalculated ma'am, hehe (S305)

Based on the results of the work and interviews with S3, it can be seen that S3 understood the problem (S302 & S303) and could plan well (S304). However, in implementing the plan, S3 made an error in determining the interest rate. Nonetheless, S3's process of re-checking discovered a mistake in the calculation shown by the cross-out answers (S305). Errors in carrying out the plan are usually seen from the incompatibility of the mathematical model, completion steps, mastering some concepts and working strategies (Isnaeni et al., 2018; Komarudin, 2016; Nurdiana, 2017). Re-examining needs special attention because it is essential in solving mathematical problems to minimize technical errors, but few students feel confused about what to do in re-examining (Irfan, 2017; Kristofora & Sujadi, 2017; Ruswati et al., 2018).

CONCLUSION

From the observations of 3 subjects who have visual, auditory, and kinesthetic learning styles with the highest scores, it can be concluded that students with visual learning styles can solve social arithmetic problems based on Polya's steps, namely understanding the problem, formulating plans, implementing plans, and re-examining. Students who have a good visual learning style have the following characteristics: neat, orderly, thorough, and detailed, prioritizing appearance. Students with auditory learning styles can solve social arithmetic problems based on Polya's steps, namely understanding the problem, making plans, implementing plans, and re-checking. Students with auditory learning styles were seen reading a little more complicatedly in the problem-solving process, sometimes easily to be distracted. Students with kinesthetic learning styles can solve social arithmetic problems based on Polya's steps, namely understanding the problem, making plans, implementing plans, and re-checking. Students occasionally tap the table and their feet on the floor as if doing specific movements will provide a sense of comfort to provide stimulation in solving mathematical problems. There was no significant difference in students' problem-solving with visual, auditory, and kinesthetic learning styles. However, it can only be seen from the body gestures and attitudes that appear when solving mathematical problems.

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