

Students' Difficulties in Mathematical Literacy Based on Keirsey Personality Types

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Received: May 31, 2026

Revised: August 2, 2026

Accepted: September 20, 2026

Abstract

Mathematical literacy involves not only the ability to obtain mathematical answers but also the skills of formulating, employing, and interpreting. This study aimed to analyze students' difficulties in solving mathematical literacy problems based on Keirsey personality types. A qualitative approach with a case study design was employed. The initial participant pool consisted of 20 students who completed the Keirsey personality questionnaire and a mathematical literacy test based on PISA problems. Based on personality type categorization and data completeness, four primary subjects were selected: Artisan (SA), Guardian (RF), Idealist (SY), and Rational (FA). Data were collected via personality questionnaires, mathematical literacy tests, and semi-structured interviews, then analyzed through data reduction, data presentation, and conclusion drawing. The results revealed that the four subjects experienced difficulties with distinct characteristics. At the formulating stage, all four subjects struggled to translate problems into mathematical representations. At the employing stage, all four subjects encountered difficulties regarding the strategy application indicator. Difficulties concerning the application of mathematical facts, rules, algorithms, and structures were experienced by the Guardian and Rational subjects. At the interpreting stage, subjects across all Keirsey personality types faced challenges in interpreting the mathematical results they obtained. These findings indicate that Keirsey personality types offer a valuable perspective for understanding the variations in students' difficulties during the mathematization process. The study's implications highlight the importance of providing scaffolding tailored to the specific characteristics of the students' difficulties.

Keywords: Keirsey Personality Type, Mathematical Literacy, Mathematization Process, PISA Problems, Student Difficulties

INTRODUCTION

The challenges of life in the 21st century are getting harder and more complicated. Mathematical literacy is a skill that every student needs. It helps people deal with life in the century (Rizki & Priatna, 2019; Sugiarto et al., 2020). This idea is backed up by (Stacey, 2011) who says mathematical literacy is the math understanding and skill that helps with life. It includes not basic math, like what you use when you go shopping but also the preparation, for using math in high-level jobs. According to (Steen et al., 2007) Mathematical literacy is the ability of a student to use knowledge and understanding to solve problems. It is the ability of a student to use knowledge and understanding to solve problems. (Stacey & Turner, 2015) say mathematical literacy is the ability to create, use and explain math in situations. This includes facts, ideas, steps, uses, thinking and tools. It helps describe explain and predict things. It helps people make helpful choices. Mathematical literacy needs people to understand, look at explain, judge and combine information. Then they need to make a math model and find solutions to problems by using ideas (Suciati et al., 2020).

These demands are reflected in the characteristics of PISA assessment items, which position contextual problem-solving as a crucial component of measuring mathematical literacy.

PISA problems typically present scenarios that cannot be resolved through the direct application of a single procedure; instead, they require a process involving understanding the context, identifying relevant information, selecting a strategy, engaging in mathematical reasoning, and evaluating and interpreting the results (Silver & Snider, [2014](#)). Such problem characteristics mean that students may encounter distinct challenges at various stages of the problem-solving process. Variations in how students approach these mathematical problems are not solely linked to cognitive abilities but can also be influenced by individual student characteristics (Rahimah, [2023](#)). (Breit et al., [2025](#)) notes that individual differences among students in solving mathematical problems are associated with psychological characteristics. One characteristic that is theoretically relevant to examine is personality type. Personality relates to an individual's tendencies regarding how they receive information (Romadona, [2016](#)), respond to situations, regulate behaviour, and make decisions (Nadifa & Selian, [2026](#)). In the context of mathematical problem-solving, these differences likely influence how students comprehend information within a problem, determine solution strategies, manage their thought processes, and review the results obtained (Asroriyah & Mahmudah, [2025](#); Heppner & Krauskopf, [1987](#)).

The international PISA study examines the mathematical literacy of students in many nations, for example, Indonesia (Masriyah & Firmansyah, [2018](#)). The main goal of the PISA assessment is to measure the capacity of 15-year-old pupils to apply their numerical competence and knowledge to solve real-world situations (Widjaja, [2011](#)). The mathematical literacy of Indonesian pupils in PISA is always below the OECD average (Andari & Setianingsih, [2021](#); Wulandari & Azka, [2018](#)). In 2022, Indonesian students' average mathematics score was 366, compared to the OECD average of 472 (OECD, [2022](#)). In mathematics, only 18% of Indonesian pupils reached Level 2 or above, compared to an OECD average of 69% (OECD, [2022](#)). The poor average PISA scores in mathematics imply that students still have trouble answering problems related to mathematical literacy.

Factors, internal and external, cause differences in the way children solve mathematical literacy problems (Saputri et al., [2026](#)). One of the internal factors that influences personality type is (Sitorus et al., [2025](#)). Everyone has different qualities that determine the procedures and stages used to formulate, construct, and solve problems (Awaludin et al., [2021](#)). Therefore, the difficulties faced in solving mathematical literacy problems are different. Psychologist David Keirsey has classified personality types into four groups: logical, artisan, idealist, and protector (Keirsey, [1998](#)). Each group has its characteristics: (1) Guardians like to have detailed instructions when performing tasks; (2) Artisans are diligent within a particular context but are spontaneous, hasty, and less meticulous and may become bored if they have to focus a lot or think deeply; (3) Rationals like logical explanations, learn abstract ideas quickly, see problems quickly, and apply strategies systematically and sequentially; and (4) Idealists prefer to work on tasks alone rather than in groups, enjoy reading and writing, and see issues more broadly (Bates & Keirsey, [1978](#)). These differences in personality contribute to different ways of thinking and varied challenges when students work on mathematical literacy problems.

(Sugiarto et al., [2020](#)) conducted a relevant study by (Selan et al., [2020](#)), which revealed that only a few students met all the mathematical literacy markers; most students had difficulty analysing their mathematical literacy skills based on choleric and sanguine personality types. The results indicated that choleric pupils could answer mathematical literacy tasks up to Level 4, while sanguine students experienced difficulties in handling such problems. Another study conducted by (Selan et al., [2020](#)) revealed that only a few students met all the mathematical literacy markers; most of the students had difficulty in solving mathematical literacy questions containing "change and relationship" content. Research by (Ramiartiah & Hidayati, [2019](#)) showed that certain students still have difficulty articulating issues into mathematical models, which results in errors when creating solution plans. This relevant research indicates a connection between mathematical literacy ability and individual characteristics, as well as the mathematisation procedures that pupils use to solve problems. This study aims to explore the relationship between personal qualities and the mathematisation methods that children use to

solve problems. Prior studies have found that students had difficulty answering problems of mathematical literacy but have not yet addressed the differences in challenges based on Keirsey personality types. In addition, this study seeks to extend the scope of investigation to the setting of PISA tasks and to do a more detailed analysis of the obstacles that students have while attempting to solve them.

This research contributes to mathematics education by enriching the study of mathematical literacy through the integration of the four Keirsey personality types and by revealing the patterns of mathematical literacy abilities and difficulties associated with each personality type; furthermore, the research findings can serve as a basis for teachers to design instruction, provide scaffolding, and develop mathematical literacy assessments tailored to students' characteristics

METHODS

The method used in this study was descriptive with a qualitative case study approach. The subjects of this research were the ninth-grade students of SMP IT Az Zahra Takengon, Central Aceh. The study was carried out on one class, IX-A, consisting of 20 pupils. All pupils were given the (Keirsey, 1998) personality type questionnaire to find out the distribution profile of the four temperaments: Guardian, Artisan, Idealist, and Rational. The answers of the questionnaire were used to form an overall profile of the class and to identify particular research subjects. Then four target participants were selected, one from each personality type. The determination of one representative of each type is purposively done based on several considerations, namely: (1) the result of the questionnaire shows a clear tendency to one of the four Keirsey types; (2) the student can express the way of thinking; (3) the student takes part in all stages of data collection; and (4) the student is willing to be the subject of research. The mapping results of the distribution of Keirsey personality types are given in Table 1.

Table 1. Distribution of Keirsey Personality Types

Keirsey Personality Types	Number of students	Percentage	Focus Subject
Artisan	6	30%	SA
Guardian	3	15%	RF
Idealis	5	25%	SY
Rational	6	30%	FA
Total	20	100%	4 Students

To safeguard the confidentiality of the respondents, the identity of the chosen respondents was disguised with the codes SA (Artisan), RF (Guardian), SY (Idealist) and FA (Rational). The concentration on four topics was underpinned by a qualitative case study design that aimed to obtain an in-depth understanding of the characteristics of difficulties experienced in mathematical literacy tasks among different personality types rather than making statistical generalisations to the entire student population. The data were acquired using mathematical literacy tests and interviews and then analysed using the Miles and Huberman approach. Data credibility was established using triangulation. The instruments used in the study were the Keirsey personality test, the mathematics literacy test and the interview guidelines. The mathematical literacy test contained six questions from the 2012 PISA evaluation of the OECD, measuring competency levels 1 to 6. The items were categorised according to the PISA 2012 classification in terms of difficulty level, mathematical content, context, and the process of mathematisation. The exam items were translated into the Indonesian language while maintaining the meaning, context, quantitative information, mathematical demands, and difficulty level of the original items. The assessment indicator framework was designed according to the PISA 2012 paradigm, particularly the processes of formulating, employing and interpreting (see Table 2).

Table 2. Indicators of Students' Difficulties in Completing Mathematical Literacy

Mathematization Process	Difficulty Indicator
Formulating	a. Students are unable to recognize the mathematical aspects of problems in real-world contexts and problem variables; b. Students cannot convert problems into mathematical language or representation;
Employing	a. Students are unable to create and apply methods to obtain math answers ; b. Students cannot apply facts, rules, algorithms, and mathematical structures to obtain answers ;
Interpreting	a. Students cannot interpret the mathematical results obtained

RESULT AND DISCUSSION

Result

The results of the PISA tasks (levels 1 through 6) performed by research subjects—selected based on Keirsey personality types and using mathematical process indicators—are presented in Table 3.

Table 3. Student Work Results Based on Keirsey Personality Type

Process	Indicator	SA (Artisan)						RF (Guardian)						SY (Idealis)						FA (Rational)					
		1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Formulating	Identifying mathematical aspects and variables	√	-	-	-	-	-	√	√	-	-	-	-	√	√	√	√	√	√	√	√	√	√	√	√
	Translating a problem into mathematical language or representation.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Employing	Developing and applying methods	-	-	-	-	-	-	-	-	-	-	-	-	-	-	√	√	-	-	-	-	-	-	-	-
	Applying mathematical facts, rules, algorithms, and structures.	-	√	√	√	√	√	-	-	-	-	-	-	√	√	√	-	√	√	√	-	-	-	-	-
Interpreting	Interpreting mathematical results	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Key:

√ = student demonstrated performance at the PISA process and level.

- = student did not yet demonstrate performance at the PISA process and level.

Table 3 reveals that pupils with the artisan, guardian, idealist, and rational personality types are still having difficulty in solving mathematical literacy challenges. None of these personality types fully met the essential signs in all mathematical activities (formulating, utilising and interpreting). The next part explains the problems pupils face in solving mathematical literacy problems based on their Keirsey personality type.

Answers of SA Subjects with Artisan Personality Types

Figure 2 displays handwritten answers for six mathematical problems (1-6) by subjects with Artisan Personality Types. The answers are annotated with boxes explaining the errors:

- Problem 1:** minyak salad : 85 ml, cuka : 45 ml, kecap : 20 ml. Annotation: Recognizes the mathematical aspects of the problem but is incomplete.
- Problem 2:** 3.20 zeds karena sewa non-anggotanya adalah 3.20 zeds. Annotation: Students do not apply strategies when working on.
- Problem 3:** jika 45 x 150 maka hasilnya 67.50. Annotation: Students misapply strategies.
- Problem 4:** $D = \frac{dv}{60n}$ and $D = \frac{dv}{120n}$. Annotations: Students cannot change problems into mathematical language; Students apply incomplete strategies.
- Problem 5:** luas total atap adalah 500 jika dilihat dari depan dan 600 jika dilihat dari samping. Annotation: Students do not apply strategies in answering.
- Problem 6:** 2.000.000 zeds jika dikurangi 20%. Annotation: Students cannot change problems into mathematical language.

Figure 2. Answers of SA Subjects with Artisan Personality Types

During the *formulation process*, SA subjects were unable to recognize the mathematical aspects of the given problems. Of the mathematical literacy questions from levels 1 to 6, only level 1 included mathematical aspects, but they were incomplete. SA subjects were also unable to translate known problems into mathematical language. Because they were unable to recognize mathematical aspects and translate problems into mathematical language, students were unable to find strategies for solving mathematical literacy problems.

In the process of *employing* the SA subject, he was unable to apply strategies when solving mathematical literacy problems, and the SA subject was unable to solve problems at level 1. For level 2 questions, subject SA answered the non-member rent was 3.2 Zed without paying attention to the information and what was asked, such as membership fees, member fees, total rental, and member fees. For level 3 questions, subject SA was wrong in applying the strategy; subject SA only multiplied 45 by 150 even though 45 is an angle and its value must be found. Because of the wrong strategy application, the calculation was also wrong. In level 4 questions, subject SA was able to write a strategy by obtaining two formulas, namely $D = \frac{dv}{60n}$ and $D = \frac{dv}{120n}$ but was unable to complete the next calculation. In level 5 questions, subject SA did not apply the strategy and only guessed in answering the questions. In level 6 questions, subject SA was unable to answer the problem asked.

In the *interpreting process*, the SA subjects did not carry out any interpretation for level 1 to level 6 problems. Research results for subject SA show that interpretation is the weakest stage of the mathematical literacy process. The learner tended to stop at the result of a computation without linking it to the context of the problem. The inability to interpret was not only because of the difficulty level of the tasks, as the student failed to produce interpretations even for problems involving relatively easy operations in mathematics. The difficulty was likely due to a problem-solving technique that focused on achieving a final response, insufficient metacognitive skills for monitoring and evaluation, and a lack of expertise in connecting mathematical conclusions to the current scenario.

The analysis results above The following excerpt from the researcher's interview with subject SA supports the analysis results above. The following excerpt from the researcher's interview with subject SA supports the analysis results mentioned earlier.

R : What were the mathematical aspects involved in question no. 1?
SA : For no. 1, I just added the numbers up.

- R : Oh, so you didn't identify the specific mathematical elements?
 SA : The ingredients: salad oil, vinegar, and soy sauce.
 R : Right, and how much salad oil was there?
 SA : 60 ml of salad oil, 30 ml of vinegar, and 10 ml of soy sauce.
 R : For what total recipe volume?
 SA : 150 ml.
 R : What strategy did you use to solve question no. 1?
 SA : Addition.
 R : You didn't write down the mathematical elements for questions no. 2 through 6, did you?
 SA : That's right.
 R : What strategy did you use to solve questions no. 2 through 6?
 SA : For question no. 2, the answer was 3.2 zeds.
 R : Where did you get 3.2 zeds? What strategy did you use?
 SA : Since the question specified "non-member," I applied the non-member rental rate.
 R : I see; so because they weren't a member of the rental service, you wrote down 3.2 as the result.
 SA : Yes.
 R : For no. 3, the result was 67.5. What strategy did you use?
 SA : Multiplication.
 R : What did you multiply?
 SA : 45 times 150.
 R : For no. 4, you obtained $D = \frac{dv}{120n}$. What strategy did you use?
 SA : For no. 4, I just doubled the 60.
 R : So, it became 120? For no. 5, the result was 500 when viewed from the front and 600 when viewed from the side. What strategy did you use to get those results?
 SA : From the bottom view.
 R : You just added the numbers up?
 SA : Yes.
 R : For no. 6, you got 2,000,000 zeds after a 25% reduction. Can you explain the strategy used to get that result?
 SA : The 500 from yesterday was deducted.
 R : Where did the 500 come from?
 SA : From the completion fee.

Answers of RF Subjects with Guardian Personality Types

1. minjak salad = 60 ml cuka = 30 ml kecap = 10 ml 30 ml = 90 ml	Students recognize the mathematical aspects in the problem but are not complete. Students do not apply strategies
2. Dik: biaya keanggotaan tahunan 10 zeds sewa non anggota = 3120 sewa anggota = 2,50	Students recognize the mathematical aspects in the problem but not completely.
3. 	Students change the problem into mathematical language by drawing a triangle.

Figure 3. Answers of RF Subjects with Guardian Personality Types

In the *formulation stage*, subject RF was less familiar with the mathematical aspects of the problem. From level 1 to 6 questions, only level 1 and 2 questions wrote down the known mathematical aspects in the problem. In level 1 and 2 questions, subject RF wrote down the mathematical aspects but incompletely. For level 3 questions, subject RF transformed the known problem into mathematical language by drawing a triangle, but did not write down the mathematical aspects or the known angle of 45° .

At the *employing stage*, subject RF only worked on level 1 problems. The strategy used by subject RF on level 1 problems was simply adding the amount of salad oil, vinegar, and soy sauce. Subject RF did not understand the principle of proportion necessary to solve level 1 problems.

At the *interpreting stage*, it was not carried out by the RF subjects for questions from level 1 to 6. The analysis above is supported by the following excerpt from the researcher's interview with subject RF.

- R : For question no. 1, what mathematical aspects are given?
 RF : 50 ml salad oil, 30 ml vinegar, 10 ml soy sauce.
 R : What is being asked?
 RF : The amount of salad oil needed to make 150 ml of dressing?
 R : What strategy did you use to get the result of 95?
 RF : I don't remember anymore.
 R : For question no. 2, what are the mathematical aspects?
 RF : Annual membership fee of 10 Zeds, non-member rental fee of 3.20, member rental fee of 2.50.
 R : What is being asked?
 RF : The non-member rental fee for 1 DVD.
 R : What was your answer the other day?
 RF : I didn't answer it.
 R : What about no. 3?
 RF : I drew a triangle.
 R : Can you explain the triangle you drew?
 RF : I don't know; I don't remember anymore.

Answers of SY Subjects with Idealistic Personality Types

1 Dik = Minyak Salad = 60 Ml Cuka = 30 Ml Kecap = 10 Ml Ditanya = Minyak salad 60 + 150 Ml saus yang dibutuhkan Di jawab = 60×150 $= 210$ Ml yang dibutuhkan untuk membuat saus $= 9$	Students recognize the mathematical aspects of the problem
Ditanya = Minyak salad 60 + 150 Ml saus yang dibutuhkan Di jawab = 60×150 $= 210$ Ml yang dibutuhkan untuk membuat saus $= 9$	Students apply strategies but incorrectly
2 Dik = Sewa non anggota biaya untuk satu DVD "3.20 zeds" = Biaya anggota untuk satu DVD "2.50 zeds" Ditanya = jumlah biaya yang dikeluarkan Toni saat dia bukan anggota lagi?? Di jawab = $3.20 \text{ zeds} \times 52.50 \text{ zeds}$ $= 156.70$ zeds biaya yang dikeluarkan Toni karena bukan anggota	Students recognize the mathematical aspects of the problem
Ditanya = jumlah biaya yang dikeluarkan Toni saat dia bukan anggota lagi?? Di jawab = $3.20 \text{ zeds} \times 52.50 \text{ zeds}$ $= 156.70$ zeds biaya yang dikeluarkan Toni karena bukan anggota	Students apply strategies but incorrectly
3 Dik = Sudut = 95° Kelilingan vertikal = 150 M Panjang = 150 Sudut Siku = 90° Ditanya = berapakah Panjang Tali layang - layang Di jawab = $P \times T$ $= 150 \times 150 \text{ M}$ $= 12.500 \text{ M}$	Students recognize the mathematical aspects of the problem
Ditanya = berapakah Panjang Tali layang - layang Di jawab = $P \times T$ $= 150 \times 150 \text{ M}$ $= 12.500 \text{ M}$	Students apply strategies but incorrectly
4 Dik = $D = \frac{dv}{60n} \cdot c$ ditanya = bagaimana D berubah jika digandakan waktu tetapi d dan v tidak ada di jawab = $D = \frac{dv}{60n} \cdot c$	Students recognize the mathematical aspects of the problem
Ditanya = bagaimana D berubah jika digandakan waktu tetapi d dan v tidak ada di jawab = $D = \frac{dv}{60n} \cdot c$	Students apply strategies but incorrectly
5 Dik = Atap = Diklat depan = 2.50 Diklat Samping = 1.0 Ditanya = hitung luas total atap pada atap dilihat depan dan samping Di jawab = $2.50 + 1.0$ $= 3.60$ luas atap tersebut	Students recognize the mathematical aspects of the problem
Ditanya = hitung luas total atap pada atap dilihat depan dan samping Di jawab = $2.50 + 1.0$ $= 3.60$ luas atap tersebut	Students apply strategies but incorrectly
6 Dik = tinggi sebesar 0.42 zeds Konsumsi solar sekitar 20% layer layang - layang = 2.5000 zeds Ditanya = berapa tahun Penghematan Di jawab = $0.42 \times 20\%$ $= 220.00 \text{ zeds}$ / 22% / 22 tahun - menghemat bukan bukan	Students recognize the mathematical aspects of the problem
Ditanya = berapa tahun Penghematan Di jawab = $0.42 \times 20\%$ $= 220.00 \text{ zeds}$ / 22% / 22 tahun - menghemat bukan bukan	Students apply strategies but

Figure 4. Answers of SY Subjects with Idealistic Personality Types

In the *formulation stage*, subject SY was able to recognize the mathematical aspects in questions from levels 1 to 6. Subject SY wrote down what was known and asked questions from levels 1 to 6. Although subject SY could write down the known mathematical aspects, subject SY was unable to change the problem into mathematical language. For example, it can be seen in questions from levels 2 and 3. In questions from level 2, subject SY did not consider the number of DVDs rented as a variable so that the results of subject SY's answers did not produce a one-variable equation. In questions from level 3, subject SY was unable to change the problem into mathematical language by describing the problem in the form of a triangle by paying attention to the known angles, resulting in subject SY making a mistake in applying the solution strategy.

At the *employing stage*, subject SY applied the wrong strategy on questions from levels 1 to 6. In level 1, subject SY applied the addition strategy by adding 60 ml of salad oil with 150 ml of sauce, even though the question was about the amount of salad oil used to produce 150 ml of sauce. Subject SY did not understand the concept of comparison in solving questions at level 1. In level 2, subject SY applied the multiplication strategy by multiplying the non-member rental fee by the total member and rental fee. Subject SY did not know the concept of one-variable linear equations in solving problems at level 2. For level 3, subject SY applied the strategy by multiplying the height of the rope by the height of the rope. Subject SY did not pay attention to the known angle, namely the 45° angle. Subject SY did not know the concept of trigonometric comparison (sin, cos, and tan rules) for solving problems at level 3. For level 4 questions, subject SY applies a strategy by adding $60n$ and $20n$ to obtain $D = \frac{dv}{60n+20n} = \frac{dv}{80n}$. Subject SY does not understand the concept of comparison to solve problems at level 4. In level 5 questions, subject SY applies the concept of addition by adding $2.5 + 1.0$. Subject SY does not notice that the roof is in the shape of a right triangle. Subject SY does not know how to solve problems at level 4 using the concept of the Pythagorean theorem. In level 6 questions, subject SY uses a multiplication strategy by multiplying the fuel cost of 0.42 Zed by a consumption of 20%. Subject SY does not pay attention to other information in the questions, such as annual diesel consumption and the cost of installing a kite. Because the strategy used by subject SY is incorrect for level 1 to 6 questions, it causes the application of rules, algorithms, and structures to be wrong.

At the *interpreting stage*, subject SY did not do this for questions from level 1 to 6. The analysis results above are supported by the following excerpt from the researcher's interview with subject SY.

- R : What mathematical aspects are identified in question no. 1?
 SY : 50 ml salad oil, 30 ml vinegar, 10 ml soy sauce.
 R : What is being asked?
 SY : The question asks, for instance, for the amount of salad [dressing] needed to make 150 ml of this sauce.
 R : What strategy was used to solve no. 1?
 SY : Addition.
 R : What is being added?
 SY : Salad oil and sauce; the result is 210 ml.
 R : So, it is just adding 60 ml and 150 ml, then? Now, for no. 2, what are the mathematical elements?
 SY : Given non-member rental is 3.2 Zeds per DVD; member cost is 2.50 Zeds.
 R : What is being asked?
 SY : The total cost Toni incurs when he is no longer a member?
 R : What strategy was used to solve question no. 2?
 SY : Multiplication; 3.20 Zeds multiplied by 52.50 Zeds equals 156.70.
 R : Now for no. 3; what mathematical elements are present in no. 3?
 SY : A 45° angle, a vertical height of 150 m, a length of 150, and a 90° right angle.
 R : What are the instructions?
 SY : What is the length of the kite [string]?
 R : What strategy was used?
 SY : Length times height. 150 times the height of 150 m; the result is 12,500 m.
 R : List the mathematical elements in question no. 4.
 SY : Given: $D = \frac{dv}{60n}$.
 R : What is being asked?

- SY : How does D change if n is doubled, while d and v remain unchanged?
 R : What strategy was used for question no. 4?
 SY : $60n$ plus $20n$ equals $80n$.
 R : For number 5, what are the mathematical elements?
 SY : We are given the roof dimensions: 2.50 when viewed from the front and 1.0 when viewed from the side. The question asks to calculate the total roof area based on the front and side views.
 R : What strategy is used?
 SY : 2.50 plus 1.0 equals 3.60; that is the roof area.
 R : For number 6, what are the mathematical elements?
 SY : We are given a height of 0.42 Zeds, a diesel consumption rate of 20%, and a kite sail value of 2,500,000.
 R : What is being asked?
 SY : How many years of savings?
 R : What strategy is used to solve problem number 6?
 SY : Multiplication. 0.42 multiplied by 20% results in 220 Zeds = 22% = 22 years.

Answers of FA Subjects with Rational Personality Types

1. - Diketahui = minyak salad = 60 mL
 Cuka = 30 mL
 Kecap = 10 mL
 - ditanya = berapa (mL) minyak salad yang akan digunakan untuk membuat untuk membuat 150 mL saus
 - jawab = 100 mL + 50 mL = 150 mL

2. - Diketahui = Di toko ini biaya konsumsi tahunan 10 Zeds
 - ditanya = berapa biaya yang akan dikeluarkan tadi jika dia bukan asota tetapi menyewa PVP dalam jumlah
 - jawab = 10 Zeds

3. - Diketahui = Mekarik kapal dengan sudut 45°
 - ditanya = berapa kaki panjang tali untuk layar layang-layang
 - jawab = 150 m

4. - Diketahui = Kecepatan aliran air dalam selang per menit
 - ditanya = berapa waktu yang diperlukan waktu infus tersebut
 - dijawab = tetes per menit
 mengkonversi habis infus volumenya tetapan

5. - Diketahui = gambar di atas menunjukkan dimensi dalam meter dari garasi
 - ditanya = Hitung luas total atap
 - jawab = 2.50 m²

6. - Diketahui = bahan bakar diesel yang akan dipakai sebesar 0,42 Zeds per liter
 - ditanya = berapa konsumsi solar setiap 20%
 - jawab = mengkonversi layar biar mudah dan hemat konsumsi solar

Students recognize the mathematical aspects of the problem but not completely.

Students apply strategies but incorrectly

Students recognize the mathematical aspects of the problem but not completely.

Not implementing strategy

Students recognize the mathematical aspects of the problem but not completely.

Not implementing strategy

Students do not recognize the mathematical aspects of the problem

Not implementing strategy

Students do not recognize the mathematical aspects of the problem

Not implementing strategy

Students recognize the mathematical aspects of incomplete problems.

Not implementing strategy

Figure 4. Answers of FA Subjects with Rational Personality Types

At the *formulation stage*, FA subjects were able to recognize mathematical aspects in questions at levels 1, 2, and 3, although this was incomplete. For levels 3 and 4, FA subjects were unable to recognize mathematical aspects in the questions.

At the *employing stage*, FA subjects used strategies to solve Level 1 problems, but incorrectly. In solving Level 1 problems, FA subjects added 100 mL of the prescription to 50 mL, even though the value of 50 mL was unknown in the problem. FA subjects did not understand the principle of proportion. In Level 2 through 6 problems, FA subjects did not use strategies to solve the problems.

The *interpreting stage* is not carried out by FA subjects on level 1 to 6 questions. The analysis results above are supported by the following excerpt from the researcher's interview with subject FA.

- R : What are the mathematical aspects of question no. 1?
 FA : 60 ml salad oil, 30 ml vinegar, 10 ml soy sauce.

- R : What is being asked?
 FA : How many ml of salad oil do you need to make 150 ml of dressing?
 R : What strategy did you use for question no. 1?
 FA : I added up all the salad oil, vinegar, and soy sauce, then I saw the extra 50 ml, so I added everything together.
 R : So the result was 100 ml + 50 ml?
 FA : Yes.
 R : What are the mathematical aspects of question number 2?
 FA : At this store, the annual membership fee is 10 Zeds.
 R : Is that all? Are there any other mathematical aspects mentioned in question 2?
 FA : I don't know.
 R : What is asked in no. 2?
 FA : What is the cost of renting a DVD if you are not a member?
 R : What is the answer?
 FA : 10 Zeds.
 R : Where did you obtain 10 Zeds from?
 FA : I thought the answer was 10 Zeds because the problem specifically mentions that number.
 R : What mathematical aspects are found in no. 3?
 FA : Pulling a boat at a 45-degree angle.
 R : What is being asked?
 FA : How long is the kite's tether?
 R : Where did you obtain your answer of 150 m from yesterday?
 FA : From the problem—the vertical height and the length being 150 m.
 R : So you didn't use a strategy to obtain 150 m?
 FA : No.
 R : What mathematical aspects are found in no. 4?
 FA : The drip rate of D is measured in drops per minute.
 R : Is that all?
 FA : Yes.
 R : What is asked in question no. 4?
 FA : A nurse wants to double the duration of the IV infusion.
 R : What was your answer yesterday?
 FA : The factors to consider are the rate of drops per milliliter, the timing of when the IV runs out, the total volume, and the pressure.
 R : What did you mean by your answer to no. 4?
 FA : I don't know, Ma'am; I couldn't do it.
 R : For number 5, what mathematical aspects are given?
 FA : The image above shows the garage's dimensions in meters.
 R : Are there any other mathematical aspects?
 FA : No, Ma'am.
 R : What is being asked?
 FA : Calculate the total roof area.
 R : What was your answer yesterday?
 FA : 2.5 m.
 R : Where did you get 2.5 m from?
 FA : From the roof problem—looking at it from the front, it's 2.5 m.
 R : For number 6, what mathematical aspects are given?
 FA : Diesel fuel costs 0.42 Zeds.
 R : Just that? Are there any other aspects?
 FA : No, Ma'am.
 R : What is asked in question number 6?
 FA : Reducing diesel consumption by about 20%.
 R : What was your answer yesterday?
 FA : Adding a screen to make it easier and save on diesel consumption.
 R : What did you mean by that answer?
 FA : I don't know, Ma'am; I couldn't do it.

Discussions

In the case of students with the Artisan personality type working on mathematical literacy problems at levels 1 through 6, they failed to document the aspects present in the questions, did not identify a solution method, and made errors in strategy application. This finding contradicts previous research indicating that Artisan students are capable of effectively understanding

problems and formulating solution plans (Khamidah & Suherman, [2016](#); Rabbani et al., [2022](#); Riawan et al., [2020](#)). However, these results align with the findings of (Pairunan et al., [2020](#)), who noted that students often struggle to fully comprehend problems—a difficulty evidenced by their failure to clearly state what was being asked and what information was given. People with the Artisan personality type tend to be hasty and not very thorough when they apply and carry out strategies. They might even guess answers without writing down how they got there. This aligns with (Keirse, [1998](#)) observation that Artisan personalities tend to approach tasks quickly and hurriedly. Artisan personalities also characteristically seek effective methods without considering whether their chosen approach is acceptable to others (Kasriana & Ode, [2018](#)).

In the case of students with the "Guardian" personality type solving mathematical literacy problems at levels 1 through 6, they were unable to identify the given information and the specific questions being asked. Consequently, they could not devise an appropriate strategy to solve the problems. This finding contradicts previous research indicating that individuals with the Guardian personality type are capable of navigating the problem-solving process—spanning the stages of understanding the problem, formulating a strategy, executing that strategy, and drawing conclusions (Intan Fathimah Ahmadah & Ekawati, [2021](#); Khamidah & Suherman, [2016](#); Riawan et al., [2020](#); Sari et al., [2021](#)). Because they failed to grasp the problem, these students were unable to synthesise the known information into a solution plan. This outcome differs from the findings of (Yuwono, [2010](#)), which state that individuals with the Guardian personality type are able to connect various pieces of information to solve problems.

In the case of students with an "idealist" personality type, they are capable of comprehending problems ranging from level 1 to level 6 (Ahmadah, [2020](#)). These students are able to understand the problems they face and employ strategies, even if the strategies they use are not entirely correct. This conclusion is supported by findings indicating that while idealist students are capable of solving problems, the steps they take are not always flawless (Agustin, [2018](#); Rabbani et al., [2022](#); Riawan et al., [2020](#)). Idealist students tend to prefer using routine procedures to solve problems (Ahmadah, [2020](#)); consequently, they encounter difficulties when presented with non-routine problems. Errors often occur during the application of algorithms or calculations because the initial strategy employed was incorrect.

In the case of students with a rational personality type, they are able to comprehend the problem presented but do so incompletely. Students with this personality type can grasp the problem itself but fail to translate it into a mathematical expression (Aryanto et al., [2018](#); Riawan et al., [2020](#)). A characteristic of the rational personality type is an abstract thought process that prioritises efficiency; consequently, these students tend to omit writing down the given information and the specific questions being asked (Kasriana & Ode, [2018](#)). While students with a rational personality type are capable of understanding the problem, they are unable to employ the appropriate strategy to solve it. (Riawan et al., [2020](#)) state that rational students are only able to resolve the problem at the comprehension stage.

The discrepancy between this study's findings and those of earlier studies may be attributed to variances in the conditions and characteristics of the studies. The nature of the obstacles encountered differs because each study employs different types of problems, contexts, levels of difficulty and characteristics of the students. Another aspect to consider is individual student traits like personality type, which could influence the way pupils understand information, select tactics and make judgements in solving problems. The findings for the artisan, guardian, idealist, and rational personality types in this study are case-specific patterns and do not represent the population-level effects of personality.

CONCLUSIONS

One can clearly see that for pupils with Artisan, Guardian, Rational and Idealist personality types, they have difficulties solving PISA tasks at all levels of complexity (1 through 6). This is seen in their failure to meet all markers of the mathematization process, namely formulating, utilising and interpreting. This is a reflection of their inability to meet all the

indications of the mathematization process, i.e. formulating, utilising and interpreting. The small number of participants and problem situations in the study means that the findings cannot be extended to all pupils. Teachers are advised to use scaffolding (especially for the mathematization process) to facilitate students' understanding of the phases of addressing mathematical literacy challenges. Teachers can also use modelling tactics by displaying step by step answers. As part of their interpretation students should be encouraged to go beyond simply finding a numerical answer, to follow this up with a check of their results and to relate them back to the context of the problem.

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