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Solving Smartphone Storage Management Problems: Students' Mathematical Literacy Based on Self-Regulated Learning

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Abstract. The students' mathematical literacy skills tend to be influenced by students' self-regulated learning. This study aims to analyse mathematical literacy skills based on students' self-regulated learning. The research method used was descriptive qualitative involving 40 students from one of the Islamic junior high school in Bandung Bandung, West Java. The instruments used were PISA-like mathematical literacy problem and a self-regulated learning questionnaire. The data analysis technique used the Miles and Huberman model. This model uses data collection, data reduction, data presentation, and conclusion drawing. The results showed that students with high and medium level of self-regulated learning had given correct and careful answers related to managing storage on smartphones, but the students with a medium level of self-regulated learning were careless in performing calculations. While, students with low level of self-regulated learning have been able to understand the problem carefully, even though they have difficulty finding the right answer. This reseach can be used as one of basis for developing more effective learning strategies that support the improvement of mathematical literacy through empowering self-regulated learning.

Keywords: Mathematical Literacy Skills; PISA-like Problems; Problem Solving; Self-Regulated Learning

Abstrak. Kemampuan literasi matematika siswa cenderung dipengaruhi oleh kemandirian belajar siswa. Penelitian ini bertujuan untuk menganalisis kemampuan literasi matematika yang ditinjau berdasarkan kemandirian belajar siswa. Metode penelitian yang digunakan adalah deskriptif kualitatif dengan melibatkan 40 siswa dari salah satu MTs di Kabupaten Bandung Barat, Jawa Barat. Instrumen yang digunakan adalah soal PISA terkait literasi matematika dan angket kemandirian belajar. Teknik analisis data menggunakan model Miles dan Huberman. Model ini menggunakan pengumpulan data, reduksi data, penyajian data, dan penarikan kesimpulan. Hasil penelitian menunjukkan siswa dengan tingkat kemandirian tinggi dan sedang telah memberikan jawaban yang tepat dan cermat terkait pengelolaan penyimpanan pada smartphone tetapi siswa dengan tingkat kemandirian sedang kurang berhati-hati dalam melakukan perhitungan. Sementara siswa dengan tingkat kemandirian yang rendah siswa dapat memahami permasalahan dengan cermat meskipun siswa kesulitan dalam mencari jawaban yang tepat. Penelitian ini dapat digunakan sebagai dasar untuk pengembangan strategi pembelajaran yang lebih efektif dan mendukung peningkatan literasi matematika melalui pemberdayaan kemandirian belajar.

Kata kunci: Kemampuan Literasi Matematika; Kemandirian Belajar; Pemecahan Masalah; Soal PISA

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INTRODUCTION

Mathematics plays an important role in everyday life, which can foster human thinking patterns (Anggraeni et al., 2019). Mathematics can guide someone to think logically, creatively, critically, and be skilled in solving problems in aspects of life (Novitasari et al., 2022). Ginanjar (2019) believes that mathematics is a universal science that plays an important role in various scientific disciplines, develops human thinking power, and underlies the development of modern technology. Therefore, mathematics has become a science that is considered important by the general public. This is also the basis for mathematics studied at every level of education, from elementary school to college.

Mathematics learning at the school level aims to equip students to be able to solve problems that arise in everyday life with mathematical concepts (Maghfiroh et al., 2021). The objectives of mathematics learning in Indonesia based on the Content Standards of Minister of National Education Number 22 include five competencies, namely: (1) understanding mathematical concepts, explaining the relationship between concepts and applying concepts or algorithms, flexibly, accurately, efficiently and precisely, in solving problems; (2) using reasoning on patterns and properties, carrying out mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements; (3) solving problems which includes the ability to understand problems, design mathematical models, complete models and interpret the solutions obtained; (4) communicate ideas with symbols, tables, diagrams, or other media to clarify situations or problems; (5) have an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention and interest in studying mathematics, as well as a tenacious and confident attitude in solving problems (Rinaldi & Afriansyah, 2019; Ulya et al., 2019). Based on this, Janah et al. (2019), in line with Purwati et al. (2021), argue that the objectives of mathematics subjects include aspects of mathematical literacy, where the goal to be achieved is mathematical literacy.

In general, mathematical literacy is the ability to use numbers, data, or mathematical symbols (Ratnasari, 2020). Mathematical literacy can be interpreted as a student's ability and knowledge to apply basic mathematics, such as the use of numbers and symbols, to solving problems in everyday life (Mubarak, 2019). Mathematical literacy has three aspects, namely counting, arithmetic operations, and numerical relations. Counting is the ability to identify the number of an object. Arithmetic operations are the ability to perform basic mathematical operations such as subtraction and addition. Meanwhile, numeracy relations relate to the ability to distinguish the quality of an object, such as taller, shorter, bigger, smaller, more, or less (Perdana & Suswandari, 2021). Mathematical literacy is a tool for applying mathematical reasoning to everyday problems in order to better prepare oneself to face life's challenges (Manalu &

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Khayroiyah, 2023). Based on this, mathematical literacy skills are one of the most important skills for students to master. However, in reality, the mathematical literacy skills of Indonesian students are still low.

Students' literacy skills are tested by the Organization for Economic Cooperation and Development (OECD) in the Program for International Student Assessment (PISA) at the secondary school level (age 15 years). OECD (2023) noted that the mathematics literacy achievements of Indonesian students in 2003 were ranked low, namely second lowest after Brazil out of a total of 33 countries; continuing in 2006, Indonesia still did not show improvement and was in 37th position out of 38 countries; whereas in 2009, Indonesia's position is decreasing, namely ranking last out of a total of 37 participating countries. This continued in 2012, when Indonesia was still in the last position out of 38 countries. In 2015, Indonesia overtook Brazil and was in the second lowest position out of a total of 44 countries, and the last survey in 2018 showed that Indonesia was again the country with the lowest position out of a total of 41 participating countries. Therefore, numeracy literacy is a topic of concern that is currently being hotly discussed in the field of education.

Apart from mathematical literacy skills, psychological aspects are also very important in learning. This is in line with Jayantika et al. (2020), which state that students' psychological conditions can be a determinant of learning success. Good psychological aspects can contribute to students' success in solving mathematical problems (Monica et al., 2019). One of these psychological aspects is self-regulated learning.

Self-regulated learning is a student's skill in trying to become independent by exploring information other than that provided by the teacher (Fajriyah et al., 2019). Self-regulated learning is a student's ability to carry out learning activities without coercion (Bungsu et al., 2019). In line with Egok's opinion in Nuritha & Tsurayya (2021), who believe that self-regulated learning is an effort made by students in learning based on their own motivation in mastering certain material, From these opinions, it can be concluded that self-regulated learning is a student's effort or ability to carry out learning activities independently to master certain material by exploring information based on their own motivation and without any coercion.

Self-regulated is very important in the student learning process. Students who have self-regulated learning will, of course, be ready to accept the material taught by the teacher and tend to help the teacher achieve learning goals (Werdiningsih & Khoerunisa, 2021). Apart from that, the demands of the curriculum, namely that students can solve increasingly complex problems in everyday life and reduce students' dependence on other people, are one of the reasons why self-regulated learning is important for students (Maulana et al., 2020).

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Mathematical literacy skills and self-regulated learning are very important aspects for students to master in learning mathematics. Previous research has been conducted regarding the relationship between self-regulated learning and mathematical skills. Afidah et al. (2024) tested the relationship between mathematical literacy and self-regulated learning using a realistic mathematical approach. In line with Fahmy et al. (2018), who examined the relationship between mathematical literacy and self-regulated learning in the RME learning model assisted by Geogebra. Agustiani et al. (2021) analyzed mathematical literacy thinking based on the self-regulated learning of junior high school students. Meanwhile, Yanuarto & Qodariah (2020) describe the mathematics literacy of junior high school students in terms of learning independence. However, there has been no research that has further examined students' numeracy literacy skills based on self-regulated learning in the context of solving smartphone storage management problems adapted from PISA model problems. So it is hoped that this article can add references regarding students' numeracy literacy skills based on self-regulated learning in the context of PISA model problems.

METHOD

This research is a qualitative descriptive study that aims to describe students' mathematical literacy skills in solving PISA model problems in the context of smartphone storage in term students' self-regulated learning. As an analytical method, the descriptive method collects, clarifies, analyzes, and interprets data to provide a clear view of the situation being studied. Meanwhile, the qualitative method emphasizes the researcher's efforts to understand and interpret the meaning of an event involving human behavior in a particular situation according to the researcher's own point of view.

This research was conducted at one of the Islamic junior high schools (MTs) in Bandung Barat, West Java, with 40 seventh-grade students as subjects. Subjects were taken by adapting PISA research which took students aged 15 years as subject. Data collection was carried out through the PISA model mathematical literacy instrument developed by Mouli et al. (2023) and a self-regulated learning questionnaire. The instrument was validated by a material expert before being given to students. The student learning independence instrument consists of 20 statement items with 4 answer choices, namely always (SL), often (SR), sometimes (KD), and never (TP). Determining the percentage of student answers uses the following formula (Suleang et al., 2021).

$$\text{Value} = (\text{Total Score})/(\text{Maximum Score}) \times 100\%$$

Then, students grouped based on self-regulated learning scores with the categories in Table 1.

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Table 1. Categories of Self-Regulated Learning

Persentage (%)	Categories
$v \geq (\bar{x} + SD)$	High
$(v - SD) < v < (\bar{x} + SD)$	Medium
$v \leq (\bar{x} - SD)$	Low

RESULTS AND DISCUSSION

The highest score obtained was 78.75%, while the lowest score was 42.5%. This diversity of self-regulated learning scores has implications for the diversity of students in managing their learning independently. The results of measuring the student self-regulated learning scale in more detail can be seen in Table 2.

Table 2. Descriptive Statistics of Student Self-Regulated Learning

Average	Standard Deviation	Minimum Value	Maximum Value
60,28%	8,7%	42,5%	78,75%

The number of students is 40.

Then, students' self-regulated learning scores are classified into three main groups, namely high, medium, and low. The results of student grouping based on self-regulated learning are shown in Table 3.

Table 3. The Student Grouping Based on Self-Regulated Learning

Persentage (%)	Categories	Number of Students
$v \geq (60{,}28 + 8{,}7)$	High	9
$(v - 8{,}7) < v < (60{,}28 + 8{,}7)$	Medium	21
$v \leq (60{,}28 - 8{,}7)$	Low	10

The results of data processing show that out of 40 students, there are nine who have high self-regulated learning. There are 21 students who have medium self-regulated learning. Meanwhile, there were 10 students who had low self-regulated learning. The next step for each of these criteria is to select one person using purposive sampling to find out their mathematical literacy skills through the results of working on PISA model problems. This discussion will detail the results of student self-regulated learning scores and look at the implications for mathematical literacy.

High Self-Regulated Learning Student

In the first problem, students were asked to identify the application storage space on Dania's smartphone. The problem is, how much application storage space is on Dania's smartphone? Explain! (in MB), with data initially provided regarding the details of the internal storage of the

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Dania smartphone. The student's answer was "2300 MB of applications installed on the smartphone." Based on the details of the installed applications, the total storage space used by the applications on the Dania smartphone is 322 MB + 396 MB + 268 MB + 474 MB + 361 MB + 479 MB = 2300 MB. Meanwhile, there is other information that the application storage is 2 GB or 300 MB, so in the context of this problem, it can be concluded that 1 GB is equivalent to 1000 MB. Therefore, Dania application storage of 2300 MB is the right answer. This shows that students with high self-regulated learning are able to understand GB and MB notation and convert units. The student answer can also be seen in Figure 1.

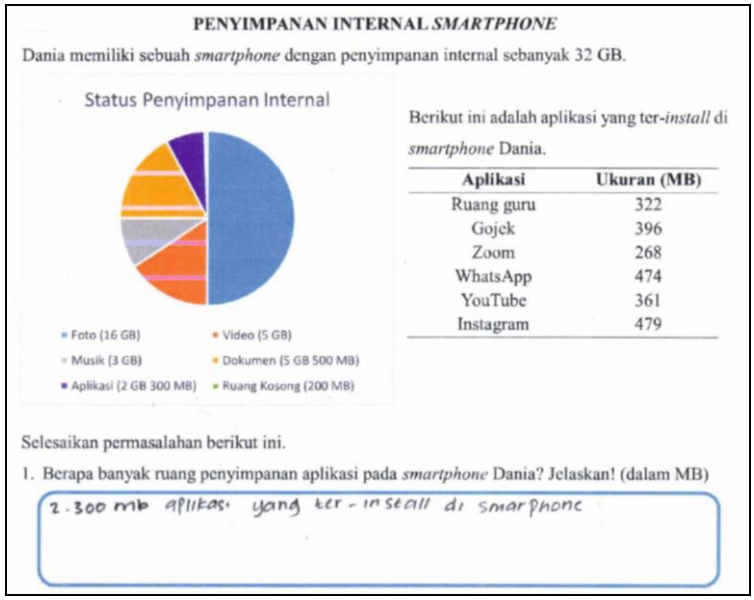

Figure 1. The Answers of High Self-Regulated Learning Student toward Problem 1

The second problem concerns the case of downloading a new application with a size of 1 GB, and students are asked to choose which two applications need to be deleted in order to be able to download the new application. The problem is that Dania will download an application with a size of 1 GB, but there is not enough storage space. Dania only wants to delete at most two applications on her smartphone. Can Dania have enough storage space to download the apps she wants? How to calculate it?. The student's answer was to delete WhatsApp and Instagram and download a 1 GB application. This student identified that deleting the Whatsapp (474 MB) and Instagram (479 MB) applications would result in an additional 953 MB of free space (474 MB + 479 MB). So, the total free space after deleting both applications is 200 MB + 953 MB = 1153 MB. This amount is more than enough to download 1 GB of new applications. The student answer can also be seen in Figure 2.

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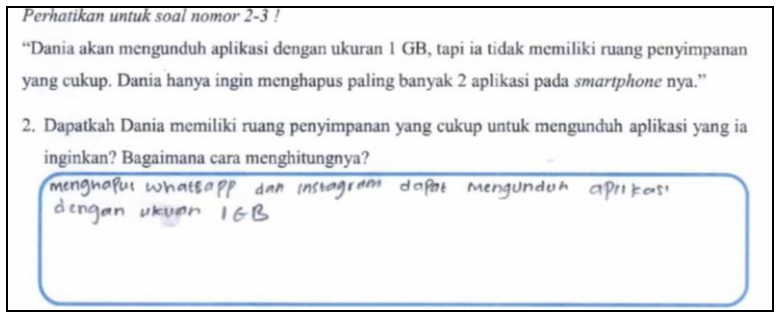

Perhatikan untuk soal nomor 2-3 !

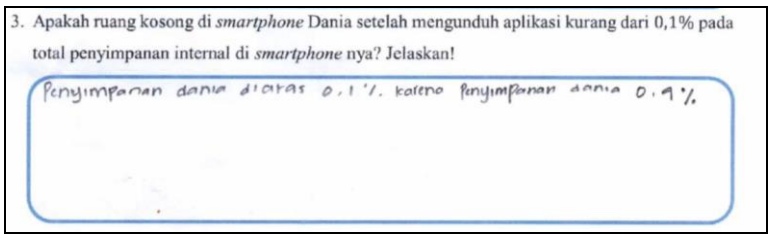
"Dania akan mengunduh aplikasi dengan ukuran 1 GB, tapi ia tidak memiliki ruang penyimpanan yang cukup. Dania hanya ingin menghapus paling banyak 2 aplikasi pada *smartphone* nya."

2. Dapatkah Dania memiliki ruang penyimpanan yang cukup untuk mengunduh aplikasi yang ia inginkan? Bagaimana cara menghitungnya?

menghapus whatsapp dan instagram dapat mengunduh aplikasi dengan ukuran 1GB

Figure 2. The Answers of High Self-Regulated Learning Student toward Problem 2

Finally, the third problem is about the percentage of free storage space to total internal storage after a new application is downloaded. The problem is, is the free space on Dania's smartphone after downloading the application less than 0.1% of the smartphone's total internal storage? Explain!. The student's answer was "Dania Storage is above 0.1% because Dania Storage is 0.4%." This answer is correct because, in reality, it is above 0.1%, and based on student number 2's answer, the free storage space is 115 MB and the total storage is 32000 MB. If you calculate the percentage, it becomes 115/3200×100% = 0.35%, so if you round it up, it becomes 0.4%. This student answer can also be seen in Figure 3.


3. Apakah ruang kosong di *smartphone* Dania setelah mengunduh aplikasi kurang dari 0,1% pada total penyimpanan internal di *smartphone* nya? Jelaskan!

penyimpanan dania diatas 0,1 %. karena penyimpanan dania 0,4 %

Figure 3. The Answers of High Self-Regulated Learning Student toward Problem 3

Of all the answers of students with high self-regulated learning on PISA model mathematical literacy problems, they have given careful answers regarding storage management on Dania smartphones. First of all, this student carefully calculated the amount of storage used by the application on the smartphone and then compared it with the available application space so that he could find out the comparison between GB and MB. Students can understand the meaning of the problems carefully. In accordance with Auliya et al. (2021), students with high self-regulated learning can identify good information in problems.

Furthermore, in dealing with the example of the storage space for downloading a new application measuring 1 GB, this student offered a practical solution by deleting the two applications that require the most storage space, namely WhatsApp and Instagram. According to Yanuarto & Qodariah (2021), students with high self-regulated learning tend to have more effective problem-solving strategies in the context of mathematical literacy. Additionally, this student also involves calculating the percentage of free space in total internal storage after downloading a new

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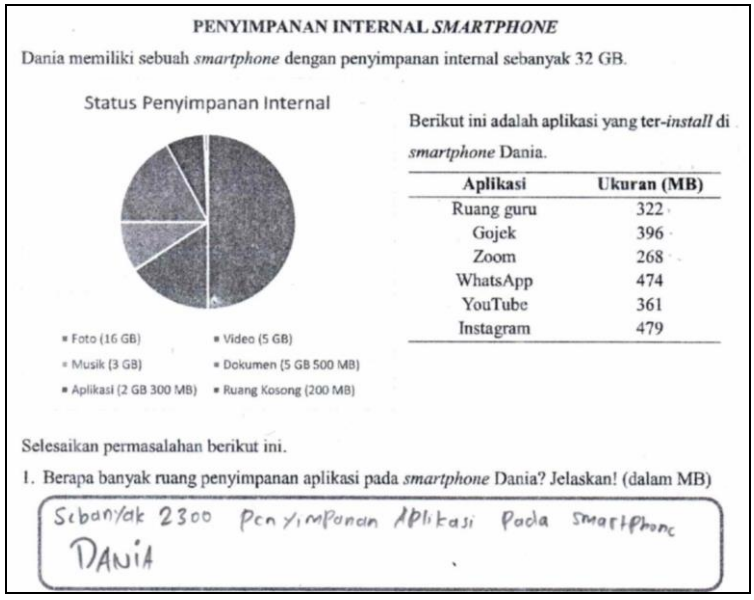
app. As a result, the student concluded that the percentage of free space after this action was still far above 0.1%. This shows a good understanding of the percentage context at large storage scales. These students' answers reflect strong analytical skills, good decision-making, and the application of mathematical concepts to real-world situations. In accordance with research by Agustiani et al. (2021), students with high self-regulated learning are able to interpret the results of problem solving into a real context and provide conclusions from problem solving.

Medium Self-Regulated Learning Student

The student answer to the first problem is “2300 Dania smartphone storage applications." This answer is correct according to the data provided, taking into account the storage space used in the application and details of the size of each application installed on Dania's smartphone. The student answer can also be seen in Figure 4.


PENYIMPANAN INTERNAL *SMARTPHONE*

Dania memiliki sebuah *smartphone* dengan penyimpanan internal sebanyak 32 GB.

Status Penyimpanan Internal

Berikut ini adalah aplikasi yang ter-*install* di *smartphone* Dania.

Aplikasi	Ukuran (MB)
Ruang guru	322
Gojek	396
Zoom	268
WhatsApp	474
YouTube	361
Instagram	479

Selesaikan permasalahan berikut ini.

1. Berapa banyak ruang penyimpanan aplikasi pada *smartphone* Dania? Jelaskan! (dalam MB)

Sebanyak 2300 Penyimpanan Aplikasi Pada Smartphone DANIA

Figure 4. The Answers of Medium Self-Regulated Learning Student toward Problem 1

The answer to the second problem from the student was "by deleting the Gojek and WhatsApp applications with 870 MB of storage." The students' answers were careful and appropriate to the context of the problem, namely taking into account the size of the two applications, whose total exceeded 800 MB. The student chose the Gojek and WhatsApp applications with a total of 870 MB, so with an additional 200 MB of free storage, he could download applications with a size of 1 GB. The student answer can also be seen in Figure 5.

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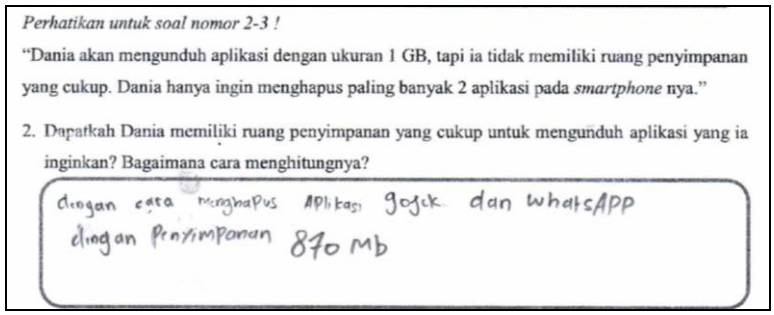

Perhatikan untuk soal nomor 2-3 !

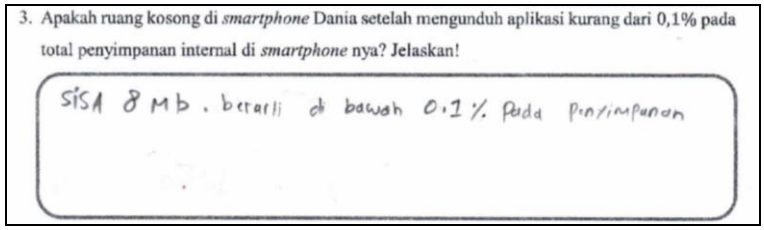
"Dania akan mengunduh aplikasi dengan ukuran 1 GB, tapi ia tidak memiliki ruang penyimpanan yang cukup. Dania hanya ingin menghapus paling banyak 2 aplikasi pada *smartphone* nya."

2. Dapatkah Dania memiliki ruang penyimpanan yang cukup untuk mengunduh aplikasi yang ia inginkan? Bagaimana cara menghitungnya?

dengan cara menghapus Aplikasi Gojek dan whatsAPP dengan Penyimpanan 870 Mb

Figure 5. The Answers of Medium Self-Regulated Learning Student toward Problem 2

The answer to the third problem from students is "8 MB remaining, meaning storage is below 0.1%." This answer is not correct because the student stated that there was 8 MB left, even though according to answer number 2, the free space should now be 1070 MB minus 1000 MB = 70 MB. So the percentage of free space to total storage is 70/32000×100% = 0.2%. So free storage space should remain greater than 0.1%. The student answer can also be seen in Figure 6.


3. Apakah ruang kosong di *smartphone* Dania setelah mengunduh aplikasi kurang dari 0,1% pada total penyimpanan internal di *smartphone* nya? Jelaskan!

SISA 8 Mb . berarti di bawah 0.1 % pada Penyimpanan

Figure 6. The Answers of Medium Self-Regulated Learning Student toward Problem 3

All student answers reflect efforts to resolve problems related to storage management on Dania smartphones. The answer to the first problem is correct, namely, 2300 MB of application storage. So students with medium self-regulated learning can identify a problem and utilize information appropriately. Furthermore, in the second answer, students also showed a good understanding of the concept of reducing storage space by deleting certain applications. Students really understand that the solution to this problem only requires freeing up a minimum of 800 MB of application storage; therefore, the solution is to delete Gojek and WhatsApp. The results of the students' answers are in accordance with Auliya et al. (2021) research that students with a medium level of self-regulated learning are able to identify problems and formulate solutions to these problems. Finally, in the answer to the third problem, the student miscalculated the remaining storage, so he was less precise in drawing conclusions from the answer. If the remaining storage is 8 MB, the student's answer is correct, namely less than 0.1%, but because the remaining storage is 70 MB, the correct answer is more than 0.1%. This means that students understand the concept of how to calculate the percentage of a portion of the whole, but there are errors in answering the remaining savings. In line with the findings of Kholifasari et al. (2020), students who have a medium level of self-regulated learning can draw correct conclusions from the problem-solving process, even if the final result is wrong. Apart from that, Yanuarto & Qodariah (2021) also stated

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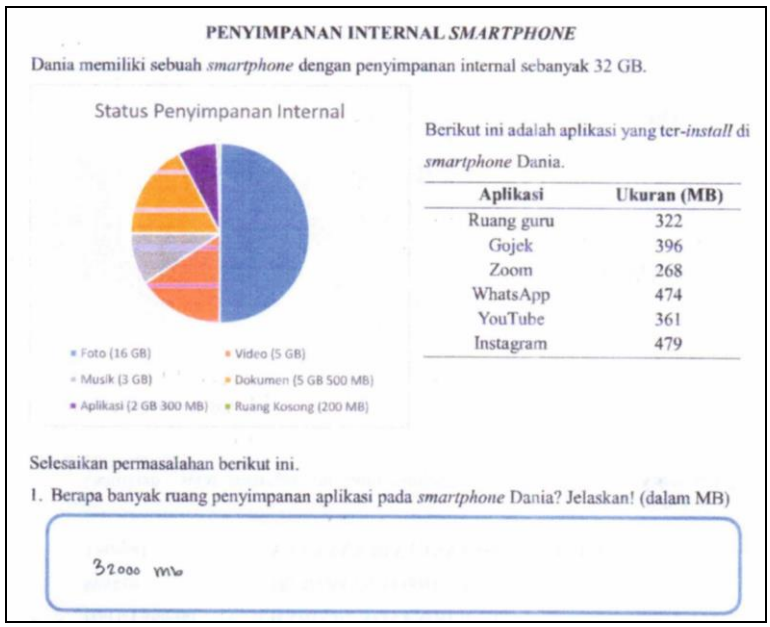
that students with medium levels of self-regulated learning are less careful when carrying out calculations.

Low Self-Regulated Learning Student

The answer to problem number 1 is "32000." The student's answer stated “32000” MB as the total storage of the Dania application. This answer is clearly wrong because it does not match the information provided previously, where the total storage of the Dania application is actually 2300 MB. Meanwhile, 32,000 MB is the total internal storage of the Dania smartphone. This shows students' lack of ability to interpret and use information appropriately. The student answer can also be seen in Figure 7.


PENYIMPANAN INTERNAL *SMARTPHONE*

Dania memiliki sebuah *smartphone* dengan penyimpanan internal sebanyak 32 GB.

Status Penyimpanan Internal

Foto (16 GB) Video (5 GB)
Musik (3 GB) Dokumen (5 GB 500 MB)
Aplikasi (2 GB 300 MB) Ruang Kosong (200 MB)

Berikut ini adalah aplikasi yang ter-*install* di *smartphone* Dania.

Aplikasi	Ukuran (MB)
Ruang guru	322
Gojek	396
Zoom	268
WhatsApp	474
YouTube	361
Instagram	479

Selesaikan permasalahan berikut ini.

1. Berapa banyak ruang penyimpanan aplikasi pada *smartphone* Dania? Jelaskan! (dalam MB)

32000 mb

Figure 7. The Answers of Low Self-Regulated Learning Student toward Problem 1

The student's answer to the second problem was "delete the Instagram and WhatsApp applications because it will provide enough storage space to download other applications." Students provide appropriate solutions by identifying applications that can be deleted to create enough storage space. This answer means students are able to identify problems and use available information appropriately. The student answer can also be seen in Figure 8.

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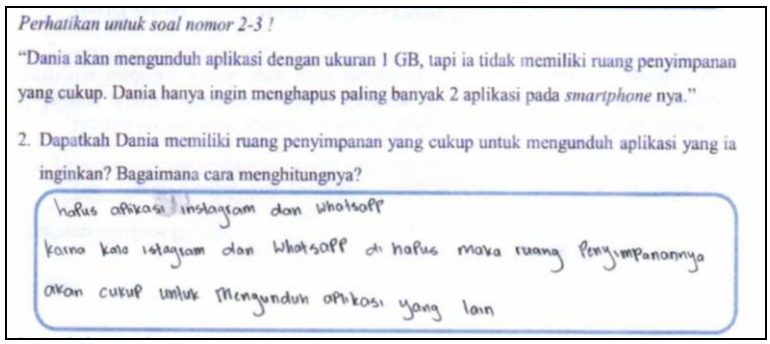

Perhatikan untuk soal nomor 2-3 !

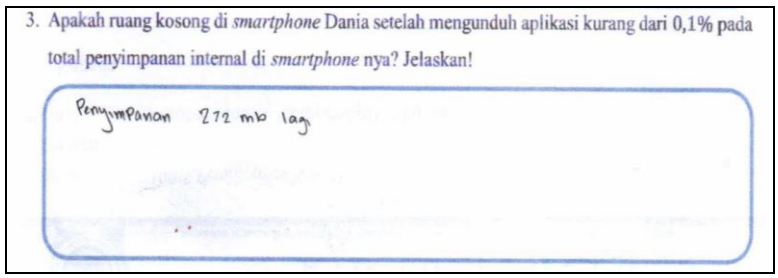
"Dania akan mengunduh aplikasi dengan ukuran 1 GB, tapi ia tidak memiliki ruang penyimpanan yang cukup. Dania hanya ingin menghapus paling banyak 2 aplikasi pada *smartphone* nya."

2. Dapatkah Dania memiliki ruang penyimpanan yang cukup untuk mengunduh aplikasi yang ia inginkan? Bagaimana cara menghitungnya?

hapus aplikasi instagram dan whatsapp
karna kalo instagram dan whatsapp di hapus maka ruang penyimpanannya
akan cukup untuk mengunduh aplikasi yang lain

Figure 8. The Answers of Low Self-Regulated Learning Student toward Problem 2

The student's answer to the third problem was "another 272 MB of storage." This answer is actually not an adequate one. To provide the correct answer, students must provide an accurate percentage calculation to determine if free space is less than 0.1% of total internal storage. These errors show students' lack of understanding of the concept of percentages and the ability to apply them correctly. The student answer can also be seen in Figure 9.


3. Apakah ruang kosong di *smartphone* Dania setelah mengunduh aplikasi kurang dari 0,1% pada total penyimpanan internal di *smartphone* nya? Jelaskan!

penyimpanan 272 mb lagi

Figure 9. The Answers of Low Self-Regulated Learning Student toward Problem 3

Overall, students' answers reflected a mix of good understanding and a lack of rigor in the application of mathematical concepts. Students demonstrate the ability to identify appropriate solutions in real situations but need to further improve their ability to provide appropriate calculations and explanations to support their answers. In accordance with the opinion of Firdaus et al. (2020), students with a low level of self-regulated learning in the process of working on problems are not good, are relatively unstructured, and do not know how to carry out the problem-solving process. Especially in this case, students have difficulty with the concept of percentage. Apart from that, Auliya et al. (2021) stated in their research that students with a low level of independence find it difficult to formulate solutions to high-level problems.

A high self-regulated learning score shows a student's ability to organize and manage their mathematics learning independently. On the other hand, low self-regulated learning scores reflect students who may need more support in developing their self-regulated learning. A medium self-regulated learning score indicates variations in students' self-regulated learning. This classification provides a basic framework to better understand differences in student self-regulated learning and prepares the basis for further analysis of mathematical literacy skills in each group. This analysis

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will pave the way to a deeper understanding of how self-directed learning can influence mathematics literacy achievement, potentially providing valuable insights for improving mathematics learning programs in the future.

From the results of the analysis of students' answers at each level of self-regulated learning above, it turns out that there is a tendency for students who have high self-regulated learning to have high mathematical literacy skills as well. At first glance, there is a positive relationship between self-regulated learning and mathematical literacy skills (Praneswari & Amidi, 2023). The results of this research can be strengthened by previous research findings that support the existence of a positive relationship between self-regulated learning and students' mathematical literacy skills. Yanuarto & Qodariah (2021) found that students who have high self-regulated learning tend to have better performance in completing contextual mathematics tasks. Indah & Farida (2021) also shows that students with good self-regulated learning have better mathematical problem-solving skills. In addition, self-regulated learning provides 24% of mathematical literacy skills. These findings provide new insights and can strengthen previous research showing that the level of students' mathematical literacy skills is influenced by their self-regulated learning. This is a challenge for the future to further increase student self-regulated learning through various methods, both learning strategies and others.

CONCLUSION

Student with high self-regulated learning have high mathematical literacy skills as well. This student was able to analyze problems carefully according to the real-world context so that every problem in the PISA model numeracy literacy problems presented can be answered correctly. While student with medium self-regulated learning was able to identify problems correctly and can utilize real information obtained even though there are a few wrong answers. In contrast, the student with low self-regulated learning can understand real problems carefully even though these students have difficulty in determining mathematical concepts so that it is difficult to find solutions to the problems presented. In further research, it is recommended to find solutions to increase mathematical literacy skills by using the PISA model and self-regulated learning for students. Thus, this in-depth research not only analyzes mathematical literacy skills in the PISA model based on self-regulated learning, but provides a basis for developing learning strategies or approaches that can improve students' mathematical literacy skills in the future.

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