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Mathematical Reasoning Skills Review of Student Self-Regulated Learning in Number Pattern

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ABSTRAK

Kemampuan penalaran matematis merupakan aspek penting yang perlu dikuasai dan dikembangkan oleh siswa dalam pembelajaran matematika. Salah satu faktor yang dapat menunjang kemampuan penalaran matematis adalah kemandirian belajar. Penelitian ini bertujuan untuk mengetahui, dan menganalisis bagaimana tingkat kemampuan penalaran matematis ditinjau dari kemandirian belajar siswa pada materi pola bilangan. Metode penelitian yang digunakan adalah metode penelitian kualitatif. Teknik pengumpulan data pada penelitian ini adalah tes, wawancara, dan observasi. Subjek dari penelitian ini adalah tiga siswa SMP kelas VIII di kampung Tabrik Desa Lingamukti Kecamatan Sucinaraja Kabupaten Garut pada materi pola bilangan. Hasil penelitian ini menunjukan bahwa siswa dengan kemandirian belajar tinggi memiliki kemampuan penalaran matematis tinggi, sedangkan siswa dengan kemandirian belajar sedang memiliki kemampuan penalaran matematis sedang, dan siswa yang memiliki kemandirian belajar rendah memiliki kemampuan penalaran rendah juga. Maka dapat disimpulkan bahwa terdapat keterkaitan antara kemandirian belajar dan kemampuan penalaran matematis.

Kata Kunci: Kemampuan Penalaran Matematis; Kemandirian Belajar; Pola Bilangan; Siswa SMP

ABSTRACT

The development of mathematical reasoning ability is essential for students as they progress in mathematics. Fostering self-regulated learning is a key factor in enhancing this ability. This study seeks to assess and analyze the impact of students' self-regulated learning on their mathematical reasoning ability in the context of number pattern material. Employing qualitative research methods, the study utilized tests, interviews, and observations for data collection. Focusing on three eighth-grade students from Tabrik Village, Lingamukti Village, Sucinaraja District, and Garut Regency, the study examined their engagement with number pattern material. According to the study's findings, pupils who exhibit high self-regulated learning also demonstrate high levels of mathematical reasoning, while those who exhibit moderate self-regulated learning also demonstrate moderate levels of mathematical reasoning, and those who exhibit low self-regulated learning also demonstrate low levels of reasoning. Thus, it can be said that developing one's independence and mathematical thinking skills are related.

Keywords: Mathematical Reasoning Skills; Self-Regulated Learning; Number Patterns; Junior High School Students

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1. INTRODUCTION

One of the most crucial elements in the development of a person's personality is education. The goal of education is to raise the caliber of human resources. Mathematics now plays a significant part in advancing science and technology (IPTEK), both materially and practically. This is supported by the belief (Arifin, 2020) that a country's success or failure is largely affected by the caliber of education provided in that country.

One of the courses taught in schools, mathematics is considered extremely significant since it helps pupils become more adept at thinking critically, logically, systematically, effectively, and efficiently. As a result, pupils should acquire mathematical knowledge as soon as feasible (Yusdiana & Hidayat, 2018). Since one of the main objectives of studying mathematics is to develop students' reasoning abilities and ways of thinking to draw conclusions and be able to articulate their thoughts with confidence to solve problems, mathematics is a science that is attained by reasoning (Akbar et al., 2018; Iswanto & Faradillah, 2023).

One crucial mathematical skill that secondary school pupils need and value is mathematical reasoning. This is supported by Hendriana et al. (2017), who argue that reasoning is essential in providing evidence for mathematical concepts. They further assert that reasoning is crucial not only in mathematics but also in life. Baroody and Nasution (Hendriana et al., 2017) also emphasize the importance of developing reasoning abilities in mathematics for expressing hypotheses based on experience.

Based on a study conducted by Isnaeni et al. (2018), it was found that a significant number of students are still facing challenges with critical thinking. Their ability to reason is not yet fully developed, and they struggle to become independent learners. Students encounter various difficulties when studying independently, ranging from a lack of understanding of key concepts to a lack of motivation to learn. This has a profound impact on their character development, as well as their learning outcomes. Additionally, research by Muharom (2014) revealed that students' mathematical reasoning skills are still not fully developed. Furthermore, according to Shadiq (2004) and Zubaidah et al. (2023), students who study mathematics require strong reasoning abilities because the thought patterns they build in the subject matter demand critical, methodical, logical, and creative thinking. It is clear from the following expert perspectives that thinking plays a critical role in the acquisition of mathematical knowledge.

Considering the significance of reasoning, a thorough examination of students' mathematical reasoning skills is required. According to Suryani (2020), children require supportive activities to develop the ability to reason mathematically. One such action is self-regulated learning, also known as self-regulated learning. Self-regulated learning, as defined by Fajriyah et al. (2019), is the capacity of pupils to independently investigate learning content from learning sources other than teachers. But as of right now, Indonesia's educational system has evolved; instead of being taught in a traditional classroom, students can now learn from home using internet resources. Students are unfamiliar with this, particularly in maths. This is because Indonesians are currently experiencing the Covid-19 pandemic (Suleang et al., 2020). Self-regulated learning is crucial for students to possess, according to Ambiyar, Aziz, and Melisa (2020), for both offline and online learning. According to Lestari et al. (2021) self-regulated learning is the process of carrying out learning activities on one's own by motivating oneself, choosing learning tactics, assessing learning outcomes, and exercising initiative to learn without the assistance of others. Pupils must acquire independence to enhance their abilities in mathematical reasoning (Mulyadi & Afriansyah, 2022). Self-regulated learning is correlated with mathematical thinking abilities, according to research by Khairunnisa, Kartono, and Suyitno (2020). When a student's ability to reason mathematically is judged based on how independent they are in their learning.

The researcher is interested in investigating how mathematical reasoning abilities are viewed from self-regulated learning based on the available data. The number pattern material is one of the resources that can show mathematical reasoning skills from students' independent learning perspectives. One of the subjects covered by grade VIII pupils at the junior high school/MTs equivalent level is number pattern material. Ariyanti and Setiawan (2019) cite observations obtained by researchers during PPL at MTs Al-Barry Cikalongwetan to support their claim that this content is among the more challenging ones for students.

Research subjects are naturally needed for a study that aims to determine the mathematical reasoning abilities of junior high school pupils in particular about self-regulated learning in number pattern material. Nevertheless, learning must be done online due to the ongoing pandemic. As a result, Kampung Tabrik was selected by the study as the research place since it is an alternative that involves conducting research in the neighborhood. But first, the researcher carried out a preliminary investigation to ascertain the degree of self-regulated learning possessed by Kampung Tabrik's eighth-grade pupils. Then, for each category of strong, medium, and low self-regulated learning, the researcher selected one subject. This aims to determine, analyze, and explain the level of mathematical reasoning ability in terms of student self-regulated learning during the pandemic.

2. METHOD

The research methodology used in this study is qualitative research, which is defined by Bogdan and Taylor (Nugrahani, 2008) as a process that yields descriptive data about the speech, writing, and behavior of the subjects. This knowledge serves as the foundation for the research's analysis of students' mathematical reasoning proficiency in terms of their capacity to acquire independence in number pattern content. The study's findings are presented in the form of a written assessment of the student's capacity for independent learning of numerical patterns using mathematical reasoning.

Students in the eighth grade of junior high school at Kp. Tabrik, Linggamukti Village, Sucinaraja District, Garut Regency, served as the study's subjects. Three children who were picked from SMPN 2 Karangpawitan who had self-regulated learning scores in the high, medium, and low ranges made up the study's subjects. Purposive sampling was the method utilized in this investigation to pick the subjects. Using the results of the self-regulated learning questionnaire that had been administered, 12 students were chosen, one subject for each of the three self-regulated learning categories: high, medium, and low. These subjects were chosen through purposive sampling.

Meanwhile, the percentage classification criteria in assessing student self-regulated learning use scaling calculations according to Sundayana (2020), presented in Table 1 below:

Table 1. Percentage Category of Self-regulated learning Questionnaire Achievement

Total Score	Interpretation
Smin ≤ ST <Smin+p	Low
Smin+p < ST < Smin+2p	Moderate
Smin+2p ≤ ST ≤ Smaks	High

Description:

Smaks : Maximum score

Smin : Minimum score

P : Length of class

The following are the results of the previous research scores for each subject selected for the research, presented in high, medium, and low criteria (see Table 2).

Table 2. Self-regulated learning Questionnaire Score Obtained

Research Subject	Total	Criteria
S-1	68	High
S-2	56	Moderate
S-3	39	Low

Table 2 indicates that research subjects S-1, S-2, and S-3 have varying degrees of self-regulated learning: S-3 has a low degree of self-regulated learning, S-2 has a moderate level, and S-1 has a high level. In the meanwhile, Table 3 below lists the traits of the three students who served as research subjects.

Table 3. Characteristics of Research Subjects

Characteristics	Research Subjects		
	S-1	S-2	S-3
Gender	Boy	Girl	Boy
Age	13 years old	13 years old	13 years old
Extracurricular	OSIS	PMR	Futsal

Characteristics	Research Subjects		
	S-1	S-2	S-3
Parents' job	Father is a farmer and mother is a housewife	Father is a construction worker and mother is a housewife	Father as a trader and mother as a housewife
Parental Education	Both are high school graduates/equivalent	Both are high school graduates/equivalent	Both are high school graduates/equivalent

The data collection techniques used in this study were tests, interviews and observations. The exam is used to assess students' proficiency in mathematical reasoning in terms of their capacity for independent learning. Following student selection based on self-regulated learning questionnaire answers, the exam is administered. Students have two hours to complete the task, each lasting forty minutes, and the test consists of identical questions. Table 4 below illustrates the process used to classify pupils' mathematical thinking abilities.

Table 4. Categories of Students' Mathematical Reasoning Abilities (Sulistiawati, Suryadi, & Fatimah, 2015)

Category	Achievement of mathematical reasoning ability
High	$X > 70\%$
Moderate	$55\% < X > 70\%$
Low	$X \leqslant 55\%$

In the meanwhile, semi-structured interviews are the kind that were used in this research. The rationale for selecting a semi-structured interview is to enable the collection of more comprehensive data that is not limited to the statements specified in the interview rules. The test results were analyzed before the interview was held. The next method of gathering data is observation. When doing an observation during the mathematical reasoning ability test, one must first complete an observation sheet, consult the supervising professor, and have the applicable validator approve it.

The qualitative descriptive data analysis method developed by Miles and Huberman, which includes the steps of data reduction, data presentation, drawing conclusion or data verification, was used in this study (Sugiyono, 2010). In the data reduction step of this study, the researcher first simplifies the interview results with a clean arrangement and corrects the test and observation outcomes. To facilitate researchers' ability to conclude, data is presented by researchers using tables and graphs. Drawing conclusions involves presenting the findings for each research subject with high, medium, and low self-regulated learning to wrap up the analysis from the data reduction and presentation stages.

Triangulation was used to verify the accuracy of the data in this investigation. Technical triangulation was the method of triangulation employed in this investigation, which checked the data's veracity using multiple approaches on the same source. To ascertain the trend of the subject's mathematical reasoning ability, the researcher verified and contrasted the data from the mathematical reasoning ability test results with the findings of observations and interviews on the same subjects.

3. RESULT AND DISCUSSION

Based on the findings of the previous study, three students were selected according to their level of learning independence: one with high independence, one with moderate independence, and one with low independence. The following sections describe some of the stages of data reduction.

The following is S-1's response to Question 1, with an indicator of the ability to present mathematical statements both orally and in writing. Figure 1 below shows the answer.

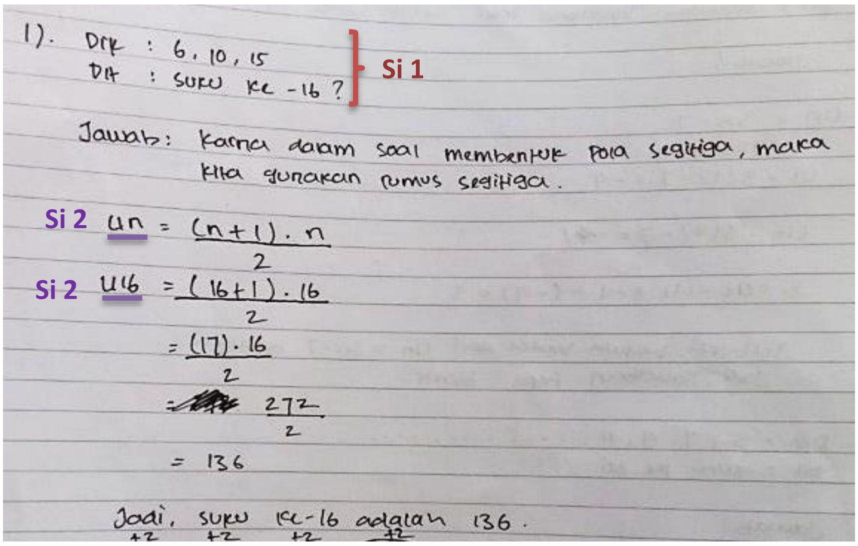


Figure 1. Answer S-1 To Question Number 1

Figure 1 shows that S-1 can write down what is known and what is asked in the question. S-1 is able to present the steps of the solution mathematically, beginning with writing the correct answer and ending with accurately determining the final result. Based on the answer, S-1 did not encounter any difficulties in solving the problem. Figure 2 shows the findings from observations conducted on S-1.

No	Aspek yang diamati	Ya	Tidak	Keterangan
Kemampuan menyajikan pernyataan matematika secara lisan dan tertulis				
1	Siswa mampu menentukan hal-hal yang diketahui dan ditanyakan dalam soal	✓		Siswa Menuliskan Pola bilangan dalam soal, dan menuliskan hal yang ditanyakan yaitu pol. bil ke-16
2	Siswa mampu mengerjakan persoalan matematika sesuai dengan aturan yang ada	✓		Siswa menggunakan rumus Pola bil. segitiga dan mengoprasikannya.

Figure 2. Results of the S-1 Observation Sheet on Question 1

Figure 2 shows that S-1 is able to identify the given information in the problem; he wrote down the information being asked by identifying the number pattern, specifically determining the 16th term; and S-1 successfully solved the mathematical problem by applying the triangular number pattern formula according to the existing rules. Meanwhile, the researcher's interview with S-1 yielded the following responses to the question:

The researcher asked, "Do you think this question is easy or difficult?"
S-1: "Easy, ma'am."
Researcher: "Can you write down what is given and what is being asked in the question?"
S-1: "I can."
Researcher: "Can you solve this question?" the researcher asked.
S-1: "I can."
Researcher: "How did you identify the pattern? Try to explain the process of answering this question."
S-1: "Because the question forms a triangle pattern, I used the triangle pattern formula, which is Un=(n+1)n/2. Since the question asks for the 16th term, I replaced n with 16 and calculated until I found that the 16^{th} term is 136."
Researcher: "Did you find it difficult to answer question no. 1?" the researcher inquired.
S-1: "No, ma'am."

According to the interview results, S-1 understands the concept required to solve question number one. S-1 is aware of both the given information and what is being asked. S-1 can explain the steps for solving the problem from start to finish in accordance with the guidelines. S-1 also recognizes that the question involves a triangle pattern, making it easier to solve. To clarify, the researcher provides a table of markers of mathematical thinking abilities.

Table 5. Mathematical Reasoning Ability Indicators in Question Number 1

Instrument	The ability to present mathematical statements orally and in writing	
	Sub indicator 1	Sub indicator 2
Test	✓	✓
Observation	✓	✓
Interview	✓	✓

Description:
✓ : Ability to fulfill
- : Inability to fulfill

Based on Table 5, it is determined that S-1 understands the questions correctly, as evidenced by their ability to fulfill the sub-indicators of reasoning ability in the test, observation, and interview instruments. For instance, sub-indicator one, which involves identifying what is known and what is asked in the questions, and sub-indicator two, which involves presenting the steps of the mathematical work from beginning to end, are both met by S-1. Question number one leads to the conclusion that S-1 understands the indicators of the ability to communicate mathematical statements both orally and in writing. The following is the response to S-2 for question number 2 with the indicator of the ability to offer conjectures, as shown in Figure 3 below:

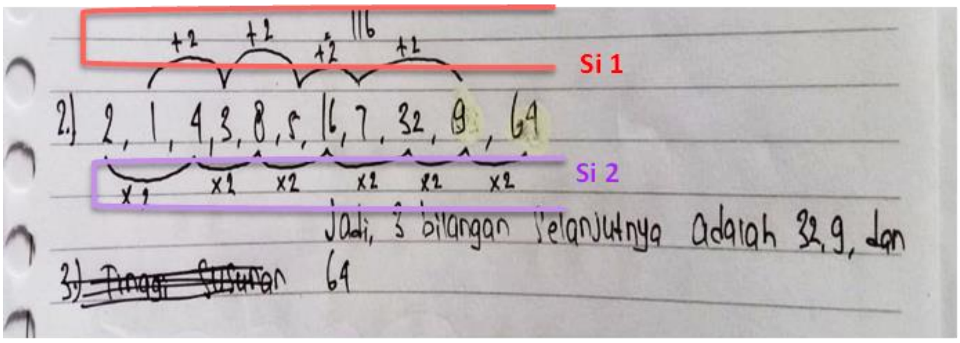


Figure 3. Answer S-2 To Question Number 2

Figure 3 shows that S-2 can solve the problem by guessing addition and multiplication. So that the right answer can be obtained when determining the next three numbers. Figure 4 shows the results of observations on question number 2 for S-2.

Kemampuan Mengajukan dugaan				
1	Siswa mampu menduga pola-pola pada soal.	✓		menggunakan pola penjumlahan dan perkalian.
2	Siswa mampu mengoprasikan soal sesuai dengan pola yang didapat	✓		mampu menemukan ketiga pola selanjutnya.

Figure 4. Results of Observation Sheet S-2 on Question Number 2

Figure 4 shows that S-2 can predict the number pattern in the question using addition and multiplication. S-2 can also operate the question based on the pattern obtained. By identifying the following three patterns. Meanwhile, the researcher's interview with S-2 yielded the following answers to the question:

Researcher: "Can you do question number 2?" .
S-2: "Do it ma' am" .
Researcher: "Can you find the pattern in the question?" .
S-2: "Can" .
Researcher: "How did you get the pattern?" .
S-2: "By adding and multiplying two by skipping one number" .
Researcher: "Did you have difficulty doing question number 2?" .
S-2: "No" .

According to the interview results, S-2 can fix problems by making further estimates. S-2 can answer problems by using multiplication approximations without facing challenges at work. To clarify, the researcher provides a table of markers of mathematical thinking abilities.

Table 6. Mathematical Reasoning Ability Indicators in Question Number 2

Instrument	Ability to make assumptions	
	Sub indicator 1	Sub indicator 2
Test	✓	✓
Observation	✓	✓
Interview	✓	✓

Description:

✓ : Ability to fulfill

- : Inability to fulfill

Based on Table 6, it is obtained that S-2 can understand the questions correctly because it can be seen that S-2 fulfills the sub-indicators of reasoning ability both in the test, observation, and interview instruments, such as sub-indicator one can solve problems with multiplication assumptions and sub-indicator two can solve problems with addition assumptions, namely being able to guess the patterns in the questions, addition, and multiplication. Question 2 concludes that S-2 understands the indicators of the ability to submit conjectures. The following is the response to S-3 on question number 3 with the indicator of the capacity to conclude from statements, as shown in Figure 5 below:

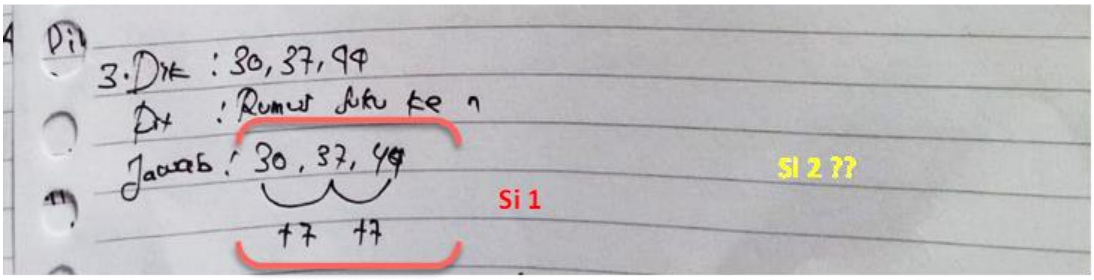
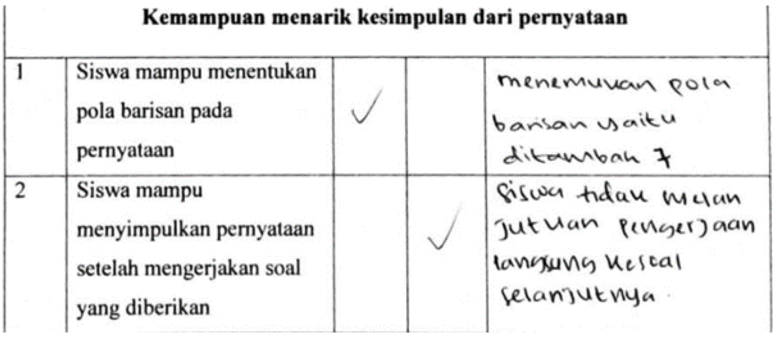


Figure 5. Answer S-3 To Question Number 3

Figure 5 shows that S-3 can detect the sequence pattern of the three statements by identifying the addition pattern. However, S-3 is unable to conclude from the pattern of the three statements by calculating the formula for the nth term. As can be observed, S-3 did not write the solution until it was finished; he was only able to identify the sequence pattern in the sentence. Figure 6 shows the findings of observations on question number 3 regarding S-3.



Kemampuan menarik kesimpulan dari pernyataan				
1	Siswa mampu menentukan pola barisan pada pernyataan	✓		menemukan pola barisan yaitu ditambah 7
2	Siswa mampu menyimpulkan pernyataan setelah mengerjakan soal yang diberikan		✓	Siswa tidak melanjutkan pengerjaan langsung ke soal selanjutnya

Figure 6. Results of Observation Sheet S-3 on Question Number 3

Figure 6 shows that S-3 may determine the statement's sequence pattern, which is added 7. However, S-3 is unable to conclude the assertion after working on the presented problem. Because he was unable to complete the assignment till it was finished. Meanwhile, the researcher's interview with S-3 yielded the following answers to the question:

Researcher: "Can you solve this problem?" the researcher asked.
S-3 says, "No, ma'am".
Researcher: "Do you find it difficult to solve the problem?".
S-3: "Yes".
The researcher asks, "Where do you find it difficult?".
S-3 Response: "I don't know how to do it ma'am but I can only determine the pattern and even then I'm not sure ma'am".
The researcher asked: "Have you ever done a problem like this before?".
S-3 says, "I forgot, ma'am".

S-3 was able to determine the order of the three statements based on the interview data. However, S-3 was unable to conclude the pattern of the three assertions by calculating the formula for the nth term; based on the interview findings, S-3 stated that he did not know how to solve the presented problem. For more information, the researcher below provides a Table of markers of mathematical thinking abilities.

Table 7. Mathematical Reasoning Ability Indicators in Question Number 3

Instrument	Ability to form conclusions from statements	
	Sub indicator 1	Sub indicator 2
Test	✓	-
Observation	✓	-
Interview	✓	-

Description:

✓ : Ability to fulfill

- : Inability to fulfill

Based on Table 7, it is determined that S-3 is unable to correctly grasp the questions, as evidenced by his inability to meet the two sub-indicators of reasoning capacity in the exam, observation, and interview. S-3 can only sub-indicator one, i.e., determine the sequence pattern of the three assertions, but not indicator two, i.e., draw conclusions from the pattern of the three statements by determining the formula for the nth term. In response to question 3, it may be determined that S-3 does not grasp the indication of the ability to draw inferences from statements. The following is the response to S-1 on question number 4 with the indicator of checking the validity of an argument, which is shown in Figure 7 below:

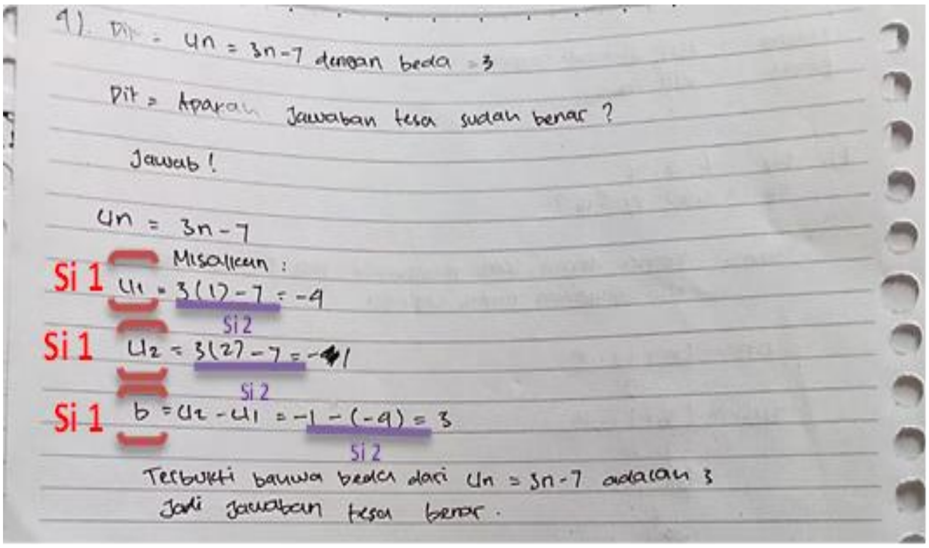


Figure 7. Answer S-1 To Question Number 4

Figure 7 shows that S-1 can solve the problem correctly using the mathematical procedures he may assume for u1, u2, and b. S-1 can also calculate and prove the problem correctly. As can be seen, he employs the formula un=3n-7 as a reference for his work, resulting in the proper findings. Figure 8 shows the findings of observations on question number 4 for S-1.

Memeriksa kesahihan suatu argument				
1	Siswa mampu menyelesaikan soal sesuai dengan langkah-langkah dalam matematika	✓		Siswa mampu menemukan u1, u2 dan b.
2	Siswa mampu membuktikan permasalahan dengan benar	✓		Siswa mampu menghitung u1, u2 dan b.

Figure 8. Results of S-1 Observation Sheet on Question Number 4

Figure 8 shows that S-1 can solve the problem using mathematical methods, first finding the difference by looking for u1 and u2. S-1 can also prove the problem correctly. Meanwhile, the researcher's interview with S-1 yielded the following answers to the question:

"*Can you do question no. 4?" the researcher asked.*

S-1: "Can".

"What information did you get?" the researcher inquired.

S-1: This means "The formula is known to be Un = 3n-7 with a difference of 3 then asked whether the statement is true or not".

The researcher asked: "What steps did you take in solving question number 4?".

S-1 is like this: "I use the formula in the question to find the difference first, I use U1 and U2 so I find U1 and U2 by using the known formula that was Un = 3n-7, then after finding U1 and U2 I find the difference by subtracting U2 and U1 so the difference is 3 ma'am".
The researcher asked: "Are you sure you have calculated and proven the problem correctly?".
S-1 says, "Sure".

According to the interview results, S-1 was able to answer the problem correctly using the mathematical procedures; he first calculated the difference between u1 and u2. S-1 was likewise able to compute and solve the problem appropriately. He was able to answer the work steps in a sequential and precise manner. For more information, the researcher provides a Table 8 of markers of mathematical thinking abilities.

Table 8. Mathematical Reasoning Ability Indicators in Question 4

Instrument	Checking the validity of an argument	
	Sub indicator 1	Sub indicator 2
Test	✓	✓
Observation	✓	✓
Interview	✓	✓

Description:
✓ : Ability to fulfill
- : Inability to fulfill

Based on Table 8, it is determined that S-1 understands the questions correctly, as evidenced by his ability to meet both sub-indicators of reasoning ability in the test instruments, observations, and interviews. S-1 is proficient in sub-indicator one, which is the ability to correctly solve questions using mathematical steps, as well as sub-indicator two, which is the ability to accurately calculate and verify problems. In question 4, it may be concluded that S-1 understands the indication for determining the validity of an argument. The following is the answer to S-2 on question number 4, with the indicator identifying the pattern or nature of mathematical phenomena to create generalizations, as seen in Figure 9 below:

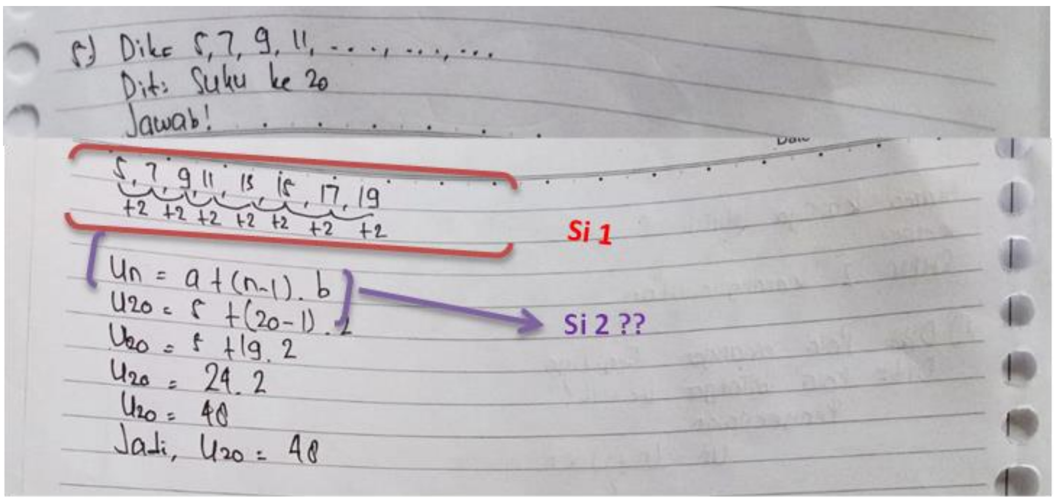


Figure 9. Answer S-2 To Question Number 5

Figure 9 shows that S-2 may determine the addition pattern. S-2 is unable to build a generalization by discovering the nth-term formula with the incorrect answer. S-2 instantly utilizes the nth-term formula but commits a calculation error, resulting in the incorrect answer. Figure 10 shows the findings of observations on question number 4 for S-2.

Menemukan pola atau sifat dari gejala matematis untuk membuat generalisasi				
1	Siswa mampu menemukan pola barisan pada soal	✓		Mampu menemukan pola penjumlahan
2	Siswa mampu membuat generalisasi dengan menemukan rumus suku ke-n		✓	Siswa langsung menggunakan rumus suku ke-n

Figure 10. Results of Observation Sheet S-2 on Question Number 5

The results of researchers' observations on S-2 show that S-2 can easily detect patterns, however, S-1 is unable to create generalizations when utilizing the nth-term formula directly, resulting in an incorrect final response. The researcher's interview with S-2 yielded the following answers to the question:

"Can you do question number 5?" the researcher asked.
S-2 says, "Got it."
The researcher asked: "Did you find a sequence pattern in the question?".
S-2: "Found it".
Researcher: "What are the next steps in answering the question?"
S(2): "After finding the pattern, I then used the nth term formula and calculated it and found the result was 48".
The researcher asked, "How did you get the result 48?"
S-2 as follows: "The n is replaced with 5, the n is 20 and the b is 2, then I subtract 20-1=19 first, then 5+19=24 and 24 times 2 equals 48".

S-2 was able to determine the addition pattern based on the interview results above, but she was unable to generalize by deriving the nth-term formula. S-1 employed the nth-term formula directly, resulting in an incorrect result due to an operation error. For more information, the researcher provides a table of markers of mathematical thinking abilities.

Table 9. Mathematical Reasoning Ability Indicators in Question Number 5

Instrument	Determining patterns or properties of mathematical phenomena to make generalizations	
	Sub indicator 1	Sub indicator 2
Test	✓	-
Observation	✓	-
Interview	✓	-

Description:

✓ : Ability to fulfill

- : Inability to fulfill

Table 9 shows that S-2 can only fulfill one sub-indicator of reasoning ability in test instruments, observations, and interviews. S-2 can meet sub-indicator one, which is to determine the addition pattern, but not sub-indicator two, which is to construct a generalization by determining the formula for the nth term. So, in question 5, it may be argued that S-2 is unable to meet the indication of detecting patterns or properties of mathematical phenomena to create generalizations.

The data given are the outcomes of a recapitulation of research instruments such as tests, observations, and interviews that were sorted and selected during the data reduction stage. The data presented comprise the findings of test analysis, observations, and interviews with sub-indicators. Table 10 shows the outcomes of students' scores on the mathematical reasoning ability test.

Table 10. Score Obtained on Mathematical Reasoning Ability Test

No	Mathematical Reasoning Ability Indicators	S-1	S-2	S-3	Average
1	The ability to present mathematical statements orally and in writing	100%	50%	50%	67%
2	Ability to make assumptions	100%	100%	0%	67%
3	Ability to draw conclusions from statements	50%	0%	50%	33%
4	Checking the validity of an argument	100%	100%	0%	67%
5	Finding patterns or properties of mathematical phenomena to make generalizations	50%	50%	50%	50%
Total		80%	60%	30%	

The mathematical reasoning ability test score data can be presented in the following graph:

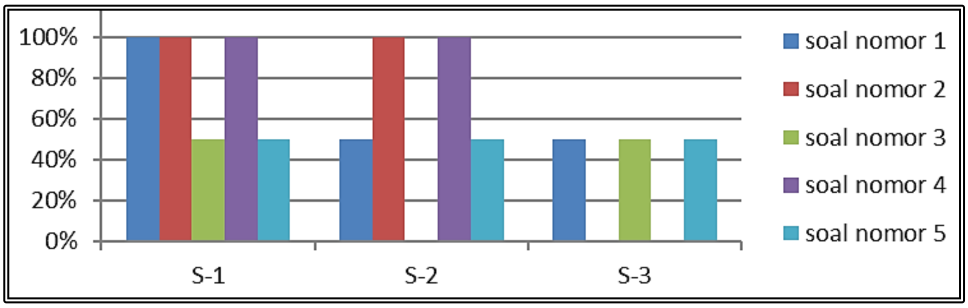


Figure 11. Mathematical Reasoning Ability Indicator Achievement Graph

Based on Table 10 and Figure 11, it is known that in indicator 1 (the ability to present mathematical statements orally and in writing) only S-1 has a percentage of 100%, meaning that S-1 is able to fulfill the indicators of the two sub-indicators given, while in indicator 2 (the ability to submit conjectures) S-1 and S-2 are able to fulfill the indicators given but S-3 is unable to fulfill the indicators, for indicator 3 (the ability to draw conclusions from statements) S-1 and S-3 have a percentage of 50%, meaning that only one sub-indicator is fulfilled in the indicator while S-2 is unable to fulfill the two sub-indicators given, then in indicator 4 (checking the validity of an argument) only S-1 and S-2 are able to fulfill the indicators while S-3 is unable, and in indicator 5 (finding patterns or properties of mathematical phenomena to make generalizations) S-1, S-2, and S-3 have the same percentage, namely 50%, meaning that only one sub-indicator can be fulfilled by the three students.

Table 10 and Figure 11 show that of the five completed test indicators, S-1 has a greater reasoning ability than S-2 and S-3, S-2 has a higher reasoning ability than S-3, and S-3 has the lowest ability among S-1 and S-2.

Based on the results of data reduction on the three instruments, namely tests, interviews, and observations of indicators and sub-indicators of mathematical reasoning, it can be presented in the form of a graph of the recapitulation of the results of the analysis of tests, interviews, and observations conducted on S-1, S-2, and S-3 on mathematical reasoning abilities as follows:

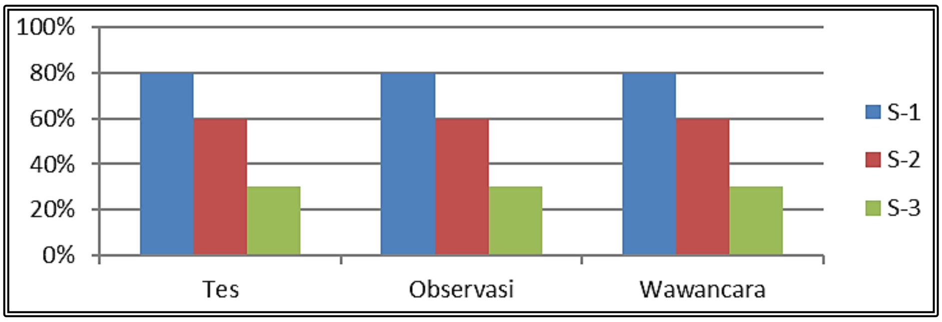


Figure 12. Summary Graph of Results of Mathematical Reasoning Ability Test Analysis, Observations, and Interviews

Based on the results of Figure 12, it is clear that the results of the analysis between tests, observations, and interviews on students' mathematical reasoning abilities experienced stability, with S-1 receiving a score that was 80% higher than S-2 and S-3, while S-2 received a score that was 60% higher than S-3, and S-3 had the lowest percentage of S-1 and S-2, which was 30%.

Based on the data analysis results reported in the research findings, it is possible to conclude that S-1's mathematical reasoning skill is 80% across all variables examined. This demonstrates that S-1 has a high level of mathematical reasoning. S-1 cannot fulfill indicators 3 (ability to derive conclusions from statements) and 5 (finding patterns or features of mathematical phenomena to create generalizations). The signs that can be met are 1 (ability to communicate mathematical statements orally and in writing), 2 (ability to submit hypotheses), and 4 (checking the validity of an argument).

S-2's arithmetic thinking skill is 60% based on all measured variables. This indicates that S-2's mathematical thinking ability is in the intermediate range. S-2 cannot meet the following indicators: 1 (ability to present mathematical statements orally and in writing), 3 (ability to derive conclusions from statements), and 5 (finding patterns or properties of mathematical phenomena to create generalizations). The markers that can be met are 2 (ability to provide hypotheses) and 4 (checking the correctness of an argument).

S-3 mathematical thinking skill accounts for 30% of all measured indicators. This indicates that S-3 mathematical thinking skills is in the low range. As can be observed, S-3 cannot fulfill any of the indicators.

b. Discussion

According to the data collected from test results, observations, and interviews with the three research subjects, only subjects with high and moderate learning independence were able to meet the indicator of submitting conjectures with correct answers, whereas subjects with low learning independence were unable to do so. This is consistent with the findings of Lestari et al. (2021), who found that students with high learning independence could submit conjectures, students with moderate learning independence could submit conjectures, but students with low learning independence could not.

Based on the data obtained through test results, observations, and interviews with the three research subjects, it shows that subjects who have high learning independence and subjects who have low learning independence get a percentage of 50% on the indicator of the ability to conclude from statements, meaning that only one sub-indicator can be fulfilled by both subjects, namely being able to find a sequence pattern from the three statements. While subjects who have moderate learning independence get 0%, this means that subjects with moderate learning independence are unable to meet the indicator of the ability to conclude from statements. In the indicator of the ability to conclude from statements, the percentage of subjects with low learning independence is greater than subjects with moderate learning independence. After being interviewed again in detail, it was true that subjects with moderate learning independence did not understand the problems given in the indicator of the ability to conclude from statements and had never worked on this type of question before, because the questions given by teachers in online learning are usually not far from what is exemplified. This causes students to be unable to meet the indicator of the ability to conclude from statements and their mathematical reasoning skills will not develop optimally. This is in line with the opinion of Linola et al. (2017), that giving questions like this will only make students procedurally skilled.

Based on the data obtained through the results of tests, observations, and interviews with the three research subjects, it shows that in the indicator of finding patterns or properties of mathematical phenomena to make generalizations, subjects with high, medium, and low learning independence have the same percentage, namely 50%, meaning that the three subjects are able to fulfill only one sub-indicator, namely the ability to determine the addition pattern, while the three Subjects with strong learning independence can solve the supplied questions and acquire the correct answers, but they cannot build generalizations since they instantly use the n-th term formula. The same applies to subjects with moderate learning independence, but the difference is that subjects with moderate independence make mistakes when operating them, resulting in getting the wrong answer. Meanwhile, subjects with low learning independence do not work on the questions until they are finished. It can be concluded that in the indicator of finding patterns or properties of mathematical phenomena to make generalizations, the three research subjects are unable to fulfill the indicator. This is not in line with the results of research conducted by Suprihatin et al. (2018) the highest percentage is in question number 3 with an indicator of determining the pattern or nature of mathematical phenomena to make generalizations of 88%. However, in research conducted by Sumarni and Sumarmo (2016), students still have difficulty in drawing generalizations and carrying out calculations based on agreed rules.

According to the results of data reduction, data presentation, and conclusion above, subjects with high learning independence perform better at solving mathematical reasoning ability questions than subjects with moderate and low learning independence because they can complete three indicators quite well, whereas students with moderate learning independence can only complete two indicators and students with low independence cannot complete all indicators. This is supported by the findings of Hidayati's (2020) study, which found that students with a high level of learning independence and interest were able to meet the four indicators of mathematical reasoning.

Another study that supports this study is one conducted by Khairunnisa, Kartono, and Suyitno (2020), who found a link between learning independence and mathematical reasoning abilities. Students with high learning independence have high reasoning ability; students with moderate learning independence have medium reasoning ability, which can be classified as good or poor; and students with low learning independence have low mathematical ability.

4. CONCLUSION

Based on the study's findings and the subsequent discussion, it is possible to conclude that students' capacity for mathematical reasoning in the context of numerical patterns has a significant and direct bearing on their ability to learn independence. Students with great self-regulated learning also have good mathematical reasoning abilities, as demonstrated by the reasoning test scores. Mathematical reasoning skills are moderate among students who exhibit moderate learning freedom. Students who struggle with self-regulated learning also struggle with reasoning. The three indicators of mathematical reasoning ability that students with high self-regulated learning can complete are number 1 (ability to present mathematical statements orally and in writing), number 2 (ability to submit conjectures), and number 4 (checking the validity of an argument). On the other hand, students with moderate self-regulated learning can complete two of the indicators: number 2 (ability to submit conjectures) and number 4 (checking the validity of an argument). Additionally, pupils who struggle with self-regulated learning are unable to meet all requirements.

The potential of a student for self-regulated learning is intimately linked to their mathematical reasoning abilities. This implies that encouraging students to develop their mathematical thinking abilities may improve their self-regulated learning. Teachers should think about emphasizing mathematical reasoning skills development more because it may result in more self-regulated learning for students. Teachers may develop their students' general capacity for self-regulated learning by having them solve problems involving numerical patterns and other reasoning exercises. The reference to reasoning test results suggests that there is evidence to support the relationship between mathematical reasoning and self-regulated learning as well as the ability to measure these skills. Thus, mathematical reasoning tests could be used by teachers to determine which students require more help to become self-regulated learning. The significance of a holistic approach to education is emphasized by this statement, which shows how improving cognitive abilities like mathematical reasoning can benefit students' academic and personal development in general and their capacity to learn and study on their own in particular.

Future research could track students over a longer period to observe how their mathematical reasoning skills evolve in relation to their self-regulated learning habits, particularly in understanding number patterns. Or maybe, investigate the role of emotional and motivational factors, such as student interest and anxiety, in the relationship between self-regulated learning and mathematical reasoning in number patterns. The study conclusively demonstrates that students' mathematical reasoning skills in understanding numerical patterns are crucial determinants of their overall self-regulated learning.

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