Sigma&Mu 3(1) (2025)

Journal of Mathematics, Statictics and Data Science

https://journals.balaipublikasi.id

Analysis of Mathematical Reasoning Abilities Based on Student's Independent Learning on Straight Line Equation Material

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Received: June 12, 2024
Revised: November 24, 2024
Accepted: March 15, 2025
Published: March 31, 2025

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DOI: 10.56566/sigmamu.v3i1.214

Abstract: Reasoning ability is a high-level thinking ability in learning mathematics. Mathematical reasoning and mathematics learning are two things that are interrelated and cannot be separated because mathematical material is understood through reasoning, and reasoning can be trained through studying mathematics. To achieve mathematical reasoning abilities in learning, students need adequate behavior, one of which is learning independence. The aim of this research is to analyze mathematical reasoning abilities based on students' independent learning at SMPN 1 Praya Timur on straight line equations. The method used in this research is qualitative research with descriptive methods. The samples in this study were taken randomly based on the class in the population. The class that the researcher took as a sample in this study was class VIII C at SMPN 1 Praya Timur for the 2023–2024 academic year. The results of this study show that subjects with low reasoning abilities are also categorized as having low learning independence. The learning ability of students who are categorized as moderate turns out to be moderate. So, it can be concluded that the relationship between learning independence and reasoning ability is based on high student learning independence, so their reasoning ability is also high. Based on the results of this research, it is hoped that teachers can develop teaching and practice problem-solving questions to improve students' reasoning abilities.

Keywords: Independent learning; Reasoning; Mathematics

INTRODUCTION

Reasoning ability is one of the goals to be achieved in learning mathematics. The Ministry of National Education (2006) states that after learning students must have a set of mathematical competencies which must be demonstrated in their learning outcomes in mathematics subjects. The mathematical skills or abilities that students are expected to achieve in learning mathematics are: (1) understanding concepts; (2) reasoning; (3) communication; (4) problem solver; and (5) have an attitude of appreciating the usefulness of mathematics in life. This is also in line with the learning objectives emphasized in the National Council of Teachers of Mathematics (NCTM, 2000), namely: (1) mathematical communication; (2) mathematical reasoning (mathematical reasoning); (3) solving mathematical problems (mathematical problem solving); (4) mathematical connection; and (5) formation of positive attitudes towards mathematics (positive attitudes toward mathematics).

How to Cite
Dewi, A. M., Turmuzi, M., Kurniawan, E., & Arjudin, A. (2025). Analysis of Mathematical Reasoning Abilities Based on Student's Independent Learning on Straight Line Equation Material. *Sigma&Mu: Journal of Mathematics, Statistics and Data Science*, *3*(1), 9–16. https://doi.org/10.56566/sigmamu.v3i1.214

Reasoning ability is a high-level thinking ability in learning mathematics. Mathematical reasoning and mathematics learning are two things that are interrelated and cannot be separated, because mathematical material is understood through reasoning and reasoning can be trained through studying mathematics. Therefore, through learning mathematics, students' reasoning abilities will be better trained. East Praya 1 Middle School students have passive reasoning abilities in solving mathematical problems, where the average score for the mid-semester exam for the 2022/2023 academic year is still relatively low. Based on the list of classical completion scores for the odd mid-semester mathematics exam class VIII at SMPN 1 Praya Timur for the 2022/2023 academic year, it has a score below the specified KKM, namely 70. Rahman, Rizki, & Maarif (2014) stated that reasoning abilities play an important role in student learning outcomes. High learning outcomes indicate good reasoning abilities, whereas low learning outcomes indicate low reasoning abilities in the student. In line with an interview with a mathematics teacher at SMPN 1 Praya Timur during the observation, many students still had difficulty dealing with mathematics problems, even though they were the easiest, because students did not use logical reasoning in solving the mathematics problems given. So reasoning is the most important aspect in learning mathematics.

The factor that causes the low level of reasoning of students at SMPN 1 Praya Timur in learning mathematics is the learning approach, which is dominated by the expectation approach, namely learning activities that are centered on the teacher and because of the factors that caused the Covid pandemic that occurred, the material to be delivered was not always achieved. Even though online teachers and students also experience difficulties in carrying out the learning process, learning effectiveness is disrupted and students experience a lack of understanding of the material. As a result, students' reasoning in learning mathematics becomes less than optimal and other learning behavior such as students' activeness and creativity in learning mathematics is almost invisible. To achieve mathematical reasoning abilities in learning, students need adequate behavior, one of which is learning independence.

Learning independence is a condition where students' independent learning activities do not depend on other people. According to Basir (2010), independent learning is defined as a learning process within a person in achieving certain goals that require being active individually or not depending on other people, including teachers. With independent learning, students can assess their own ability to understand, reason and work on a problem or problem. To examine student learning independence, it is necessary to have a cognitive attitude that plays a role in efforts to develop students' thinking processes in solving mathematical problems by reasoning, awareness of mathematics, fostering self-confidence, an objective and open attitude to face the ever-changing future. One of the cognitive attitudes that contains this is reasoning ability. For students' reasoning abilities to improve, an attitude is needed where students no longer rely on information or learning materials provided by the teacher, but students themselves can search from books or other sources. One of the attitudes in solving these problems is learning independence to look for reasons from various sources. students' basic knowledge provides correct decisions (Bernard &Chotimah, 2018). This aims to ensure that students' potential can increase and develop optimally (Sari, Purwasih, &Nurjaman, 2017).

Straight line equations are one of the pre-requisite mathematics materials for the next concept of mathematics material. In mathematics, this material can help in solving algebra problems, especially linear equations. Based on the results of an interview by one of the mathematics teachers at SMPN 1 Praya Timur, it was found that the students' mathematical reasoning abilities were low. This is because most students in the process of completing practice questions only wait for answers from friends or instructions from the teacher. So, students are not used to solving practice questions themselves. This is a problem that occurs in students' learning independence but also has an impact on their mathematical reasoning abilities.

To overcome the problems above, teachers need to improve students' mathematical reasoning abilities and learning independence. One way that can be an alternative is to apply appropriate learning strategies to improve mathematical reasoning abilities and learning independence.

According to Sumartini (2015), improving students' mathematical reasoning abilities needs to be supported by an appropriate learning approach so that learning objectives can be achieved.

However, to be able to design the right learning approach, teachers need to know the mistakes that students often experience in solving problems. From knowing the mistakes that students often make in solving problems, teachers can find mathematical reasoning abilities based on students' learning independence. The aim of this research is to analyze mathematical reasoning abilities based on students' independent learning at SMPN 1 Praya Timur on straight line equations.

METHOD

This research is qualitative research using descriptive methods. The research was carried out at SMPN 1 Praya in class VIII C in the odd semester of the 2023/2024 academic year. The population used is all class VIII students of East Praya 1 Middle School for the 2023/2024 academic year with random sampling using cluster random sampling with a sample of class VIII C of East Praya 1 Middle School for the 2023/20224 academic year with details namely 4 students consisting of 2 students with different abilities. high mathematical reasoning, 2 students with moderate reasoning abilities and 2 students with low reasoning abilities, while learning independence consists of 2 students each with high, medium and low learning independence categories.

The research instruments used mathematical reasoning ability tests, learning independence questionnaires and unstructured interviews. The data analysis technique in this research is in the form of analysis of mathematical reasoning ability tests, learning independence questionnaires and interview results by redacting the data, presenting the data and drawing conclusions.

The research procedures applied are by determining the research class, compiling research instruments, testing the validity of the instrument, giving description tests and learning independence questionnaires, determining which subjects fall into categories, analyzing data from mathematical reasoning ability tests and learning independence questionnaires, describing test result data and compiling research data.

RESULT AND DISCUSSION

Result

The research results are presented in the form of a description of the test results and questionnaires conducted by research with the research subjects. The research subjects consisted of Subject (1) was a student with a high category analysis of students' mathematical reasoning abilities based on high learning independence, Subject (2) was a student with a medium category analysis of students' mathematical reasoning abilities based on moderate learning independence and Subject (3) was a student with an analysis students' mathematical reasoning abilities are in the low category based on low learning independence. Below are the results for each test given.

Reasoning number 1 Draw a straight line with the equation 3x-2y=12!.

Subject (1) was able to solve question number 1 smoothly and with correct marks. The steps are taken by writing down what is known in the problem. Then provide reasons or evidence for several solutions by writing down the intersection points. Then, by writing the intersection points, you can create patterns or properties by entering what is known into the intersection points. So by making a graphic image as a conclusion correctly.

Subject (2) was able to do question number 1 smoothly and correctly. The first step to take is to write down what is known and what is asked in the question. Then the subject provides reasons or evidence by writing the cut-off points as a reference in writing reasons such as the second indicator. Then determine the mathematical pattern or property by looking for the intersection point on the x-axis with y= 0 and vice versa by looking for the intersection point with the y-axis with x= 0. If the result is known, then the subject makes a conclusion by drawing a graph as instructed by the

question. Subject (3) is explained in the answer sheet. Seen in the picture of answer sheet 86, it shows that the subject cannot explain how to solve question number 1. The subject only wrote what he understood but could not make the solution correct.

Reasoning number 2 Determine the gradient of the line from the following line equations (a) 2x+6y=20 and (b) 2y-8x+16=0.

Subject (1) was able to solve question number 2 smoothly and correctly. The first step to take is to write down what is known and what is being asked in the question. Then the subject provides reasons or evidence for a solution using an existing formula. After providing a solution or evidence, the subject then writes down the mathematical pattern or property by solving the problem, then the subject writes the conclusion of what is asked in the problem. In question number 2b, the first step is correct by writing down what is known and what is being asked. After that, the subject makes reasons or evidence by writing down the solution method using an equation. Then the pattern or mathematical properties are determined based on the existing equations. After knowing the results of the pattern or mathematical properties, the subject then draws conclusions.

Subject (2) was able to write the initial steps correctly in questions number 2a and 2b, namely what was known and asked. In providing reasons or evidence, the subject provides reasons or evidence by writing a straight-line equation. Then the subject creates patterns or properties of matemates by entering equations into the formula that has been written. So that in making a conclusion, write the verse correctly for questions number 2a and 2b. Subject (3) shows that the solution to numbers 2a and 2b does not exist. The subject only wrote down the numbers but not from the question but from outside the question. What is visible is only numbers without any completion which means that the subject's answer cannot be given a mark. So all indicators are not met in question number 2.

Reasoning number 3 The equation of the line that passes through point (-5,3) and is parallel to the line y=4x+9 is...

Subject (1) was less able to solve question number 3. In the first step, it was correct to write down what was known and what was asked in the question. During the step of providing reasons or evidence, the subject can correctly write down the formula used. Then, when determining patterns or mathematical properties, the subject entered the gradient incorrectly when solving. So when drawing conclusions the subject wrote an inaccurate conclusion.

Subject (2) has taken the right initial steps, where what is known and asked has been explained correctly. In the second step, provide reasons or evidence that the solution is correct by writing down the formula used, namely $y - y1 = m(x - x1)$. Then after that, it uses mathematical patterns or properties to complete the solution, but when doing the calculations the subject enters the wrong gradient value which should be 4. So, when drawing conclusions the subject gives a conclusion that is not quite right.

Subject (3) was unable to solve question number 3. Where on the answer sheet the subject only wrote the equation in the question and there was no correct solution. So no conclusions can be drawn. In fact, the subject does not show the indicators that must be met in the answer sheet at all.

Reasoning number 4 The equation of the line that passes through the point (2,-7) and is perpendicular to the line 4x-3y+8=0 is...

Subject (1) was less able to solve question number 4. At the beginning he was correct in writing what he knew and what was asked. Still, when determining the reasons or evidence for a solution, the subject cannot write down the steps and they are not in accordance with what is requested. Then, when the subject is blind, the mathematical pattern or property does write it down but does not write it down correctly. So that when drawing conclusions the subject cannot draw conclusions correctly even though they write conclusions on the answer sheet.

Subject (2) shows that the subject took the right first step by writing down what he knew and asking. During the second step, the subject did not write down reasons or evidence to support the solution, so when creating patterns or mathematical properties the subject could not, so the second and third indicators were not met. So, the next indicator is drawing conclusions from statements that are not fulfilled as well. Subject (3) only wrote questions without writing answers. This makes the subject not fulfill the 4 indicators that must be met. This makes the subject not know how to write the answer.

Reasoning number 5 The equation of the line passing through points A (-2,-5) and B(3,-7) is...

Subject (1) was less able to solve question number 5. It was seen that during the first step what was known was correct but what was asked was still not correct. When giving reasons or evidence for a solution the subject cannot write it down. Then, when determining the pattern or trait, the subject wrote down the pattern or trait, but what was written on the answer sheet was not correct. So that when drawing conclusions from the solution it becomes wrong or inaccurate. Based on the results of the subject learning independence questionnaire. From this picture, the subject got the highest score from the learning independence questionnaire, where he got a score of 69 which is almost a perfect score from the learning independence questionnaire. This shows that the subject really pays attention to learning, which greatly influences his reasoning abilities.

Subject (2) took the initial step incorrectly, knowing that when writing it down it was inaccurate. Then in the second step, by providing reasons or evidence, the subject did write it down, but it was not accurate. Then the subject cannot explain mathematical patterns or properties, so in drawing conclusions the subject does not write conclusions. Based on the results of the learning independence questionnaire from subject (2) which is categorized as Medium. From the results of the learning independence questionnaire, you can find out how interested the subject is in learning mathematics. Judging from the questionnaire, learning independence is neither high nor low, but the subject has moderate interest in learning. Even though it is moderate, it really affects the subject's reasoning ability of the subjects.

Subject (3) was unable to solve problem number 5. In Figure 4.18 the subject only wrote the equation in the problem without completing it. In question number 5, the subject also did not meet the indicators in the reasoning ability test. Based on the results of the learning independence questionnaire for subjects (3), the score was 32. In obtaining a score of 32, the subject's learning independence questionnaire included low learning independence. which is not too high and not too low. If seen from the results of the learning independence questionnaire, subjects with low learning independence greatly affect their reasoning abilities.

Discussion

Subjects with high reasoning abilities in estimating the problem-solving process can estimate what steps will be taken to solve the problem given. This is in accordance with research by Hidayat and Widodo (2015) that students with high mathematical reasoning abilities can estimate the steps to solve a problem and provide an explanation of the estimates made. This is shown by the subject writing each step in more detail in solving each question. Furthermore, subject (1) is classified as good at providing reasons or evidence for one or several solutions contained in the problem correctly. This is supported by Nisa Roisatun (2016), namely thinking towards a conclusion based on evidence and the ability to provide a reasonable explanation.

Subject (1) is good at determining the pattern or nature of mathematical phenomena to generalize contained in the problem. This is in accordance with research by Suprihatin, Maya, &Senjayawati (2018) which states that students who have mathematical reasoningabilities in the high category have good abilities in determining the pattern of a problem.

In the fourth subject indicator (1), there are some that are correct and some that are not quite right. But in subject (1) you can make conclusions from 5 questions. This is in accordance with Hidayati& Widodo's (2015) research that students with high mathematical reasoning abilitiesare

able to draw logical conclusions and provide appropriate reasons at the completion step. Meanwhile, with the independent learning questionnaire, subjects with high reasoning abilities will influence their reasoning abilities. This is in line with research conducted by Fitrani (2010) that students with high learning abilities have higher learning achievements compared to students with moderate learning independence and students with low learning independence. So that subjects with high reasoning abilities and high independence have good learning achievements.

Based on the results of tests carried out on groups of subjects who have moderate reasoning abilities. Subject (2) in estimating the solving process, has sufficient ability to be able to estimate the solving process, subject (2) is quite able to estimate what steps will be taken to solve the problem given. This is in accordance with research by Hidayati& Widodo (2015) that students with moderate mathematical reasoning abilities have sufficient reasoning abilities in estimating the steps to solve problems and providing explanations of the estimates made.

The indicators provide reasons or evidence for one or more of these solutions, which have differences as indicated by the subject. The first subject (2) was able to prove it by providing appropriate and logical reasons for each step taken. So based on the data obtained, it shows that subjects with moderate mathematical abilities, subject (2) gave appropriate and logical reasons. This can be seen through the results of problem solving carried out by the subject. This is supported by the statement (Rosiatun, 2016), namely thinking to reach a conclusion based on evidence, and being able to provide a reasonable explanation.

Next, the indicator determines the pattern or nature of mathematical phenomena to generalize. The subject (2) can make patterns or properties of mathematical phenomena to generalize the question and is correct. This is supported by Affinnas (2018) who states that students with mathematical reasoning abilities in the moderate category have good abilities in using relationship patterns to master mathematical situations. Furthermore, on the indicators to draw conclusions from this statement, there is no difference shown by the subjects. The data obtained showed that subjects with moderate mathematical abilities were not able to relate what was previously known to what was asked. But in subject (2), even though he has moderate ability, he can give conclusions even though some are not correct. For the learning independence questionnaire, subjects with moderate abilities have scores that are neither high nor low. Even though it is categorized as moderate, subjects with moderate reasoning abilities can provide good achievements. From the data obtained, subjects with moderate independence are not too far off in achievement with high reasoning abilities.

Subject (3) in estimating the completion process lacks the ability to estimate the completion process of the problem-based questions given. This is based on the two subjects not being able to write down all the information stated in the question and not being able to explain it verbally correctly. This is in line with research by Ardhyanti (2019) which states that students with mathematical reasoning abilities in the low category cannot predict the solution process because they cannot organize information so they cannot solve problems. However, this is different from the research results of Affinnas (2018) which stated that students with low mathematical reasoning abilities were able to estimate the problem-solving process.

On the indicator of providing reasons or evidence for one or several solutions, there was no difference shown by the subjects. The data obtained shows that subjects with low mathematical abilities have not been able to provide appropriate and logical reasons. This can be seen through the results of problem solving carried out by the two subjects. This is supported by Nisa Roisatun's (2016) statement, namely thinking to reach a conclusion based on evidence, and being able to provide a reasonable explanation. Furthermore, the indicators determine the pattern or nature of mathematical phenomena to generalize subject (3) who is classified as less capable in analyzing mathematical situations. Subject (3) was unable to solve the problem using what was contained in the problem correctly and fluently. The subject is unable to find a pattern of a problem. Subjects have difficulty determining formulas and how to find equations, parallel lines and perpendicular lines. As a result, the subject is unable to find regularities to formulate guesses to find the right pattern. This is in accordance with research by Suprihatin et al. (2018) which states that subjects with low

mathematical reasoning abilities can use patterns and relationships to master mathematical situations.

Next, the fourth indicator, namely drawing conclusions from the statements of the two subjects, shows no differences. The data obtained shows that subjects with low mathematical abilities have not been able to relate what was previously known to what was asked. The subject also still feels confused in working on the questions, so he is unable to draw appropriate conclusions. This is in accordance with the research results of Ardhyanti (2019) that students with mathematical reasoning abilities in the low category are unable to draw logical conclusions and provide appropriate reasons at the completion step. Meanwhile, in the learning independence questionnaire, subject (3) had low learning independence. In cases such as the learning independence of students who have low reasoning abilities, their independence is also low. This has a very strong influence on reasoning abilities because the relationship between learning ability and reasoning ability is very close. If independence is high, then reasoning ability is high which will result in student learning achievement increasing.

CONCLUSION

Based on the research results, it was concluded that: (1) There is a relationship between learning independence and reasoning ability, based on high student learning independence, their reasoning ability is also high; (2) Students who are categorized as moderate in learning ability have moderate reasoning abilities; (3) Students' learning independence that is categorized as low means their reasoning ability is also low. The suggestions in this research are that students should improve their reasoning abilities, especially in mathematics, by continuing to study and by doing mathematical problem-solving exercises that can develop mathematical reasoning abilities and it is hoped that teachers can develop teaching and problem solving practice questions to improve students' reasoning abilities.

Acknowledgements
The researchers would like to thank to The Junior High School 1 of East Praya and Faculty of Teacher and Training and University of Mataram for the support to this research.

Author Contributions
All authors have real contributions in completing this manuscript.

Funding
This research is an empirical research funded by author.

Conflicts of Interest
The authors declare no conflict of interest.

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