

ANALYSIS OF VOCATIONAL SCHOOL STUDENT'S MATHEMATICAL REASONING IN QUADRATIC EQUATION

Renata Teddy Ronny¹, Harry Dwi Putra², Heris Hendriana³

¹IKIP Siliwangi, Jl. Terusan Jenderal Sudirman, Cimahi, Indonesia
renatateddy.23@gmail.com

²IKIP Siliwangi, Jl. Terusan Jenderal Sudirman, Cimahi, Indonesia
harrydp@ikipsiliwangi.ac.id

³IKIP Siliwangi, Jl. Terusan Jenderal Sudirman, Cimahi, Indonesia
herishen@ikipsiliwangi.ac.id

ARTICLE INFO

Article history:

Received Jul 12, 2023

Revised Aug 02, 2023

Accepted Aug 14, 2023

Keywords:

Mathematical Reasoning
Quadratic Equation
Vocational School

ABSTRACT

Essay test questions in mathematics learning at Vocational High Schools show that most students have difficulty answering questions about quadratic equations, this is the basis of the research. The reason this problem can occur is because students are not careful in interpreting questions so students cannot master inductive indicators. The purpose of this study is to find out more about students' mistakes when answering questions about mathematics through analysis and description of some of the students' mistakes in answering questions about quadratic equations, therefore this study uses a descriptive method with a qualitative approach. The research subjects were students of class XI Software Engineering at a Vocational High School in Kabupaten Bandung Barat with a total of 15 students. The stages in this research are planning, implementation, and reporting. Student test results as many as three questions are used to collect data. The analysis technique used is data reduction, by presenting the data then conclusions are drawn. The results and discussion of this study showed that students made mistakes in answering quadratic equation questions. The accuracy of students towards questions number 1 and number 3 is still low, so it is necessary to do regular exercises. Students' mathematical reasoning abilities need to be honed again. It can be seen from the results of the answers to question 2 that students have not been able to interpret the questions so that inductive indicators on students' mathematical reasoning abilities have not been fulfilled.

Copyright © 2024 IKIP Siliwangi.

All rights reserved.

Corresponding Author:

Renata Teddy Ronny,
Department of Mathematics Education,
Institut Keguruan dan Ilmu Pendidikan Siliwangi,
Jl. Terusan Jend. Sudirman, Cimahi, Indonesia
Email: renatateddy.23@gmail.com

How to Cite:

Ronny, R.T., Putra, H.D., Hendriana, H. (2024). Analysis of Vocational School Student's Mathematical Reasoning in Quadratic Equation. *JIML*, 7(2), 145-152.

INTRODUCTION

Mathematics lessons are central knowledge in developing competencies to face the 21st-century environment (Hamdi et al., 2018). This is in line with the necessities of life in today's modern era. Then Wicasari & Ernaningsih (2016) added that sharpening logic through learning mathematics can train higher-order thinking skills. Furthermore, Saraswati &

Agustika (2020) said that mathematics lessons can hone logical thinking, analysis, systematic, critical, reasoning, innovation, and the ability to work together, so mathematics lessons need to be given since elementary school. Mathematics is also needed by everyone to solve various reasoning problems through the process of counting and thinking (Sumayanthi, 2021). In reasoning, students are trained to think to draw conclusions based on previous statements and proven truths (Sumartini, 2015).

In line with that, (Senjayawati & Nurfauziah, 2018) said that reasoning abilities can draw conclusions from several facts that support students to solve problems. Reasoning ability is an important ability in mathematics, students who have good reasoning abilities will be able to solve problems in various forms (Fajriyah et al., 2019). Strengthened by the opinion of Rohaeti et al. (2019) which states that mathematical reasoning ability is a good predictor for solving students' mathematical HOT (high order thinking) questions.

However, in reality, based on the results of Wanti et al. (2017) the weakness of students' mathematical reasoning abilities is evident when students cannot solve non-routine problems related to reasoning. In line with that, in the research by Wau et al. (2022) stated that 8 out of 12 Vocational High School students had moderate reasoning abilities, in this study students were less able to make assumptions correctly. One of the materials that focuses on mathematical reasoning abilities is quadratic equations. Based on the 2013 curriculum, it is known that the subject matter of quadratic equations is in class XI Vocational High School as a prerequisite material for quadratic functions.

According to Supardi (2022) quadratic equation material is one of the mathematical materials that requires a lot of student skills to analyze a problem. In line with that, Mutiarani & Sofyan (2022) quadratic equation material requires students to be independent in making decisions, for example in drawing a graph of a quadratic function. Students must be able to present ideas similar to mathematical symbols connected to pictures or graphs. In fact, there are still many students who experience difficulties in solving math quadratic equations. This also happened in the study by Siahaya et al. (2021) which stated that 13 out of 25 students with low abilities were proven when students were unable to fulfill the indicators of compiling evidence and giving reasons for the correctness of the solution.

Based on the description above, the researcher is interested in further analyzing student errors in answering quadratic equation questions on mathematical reasoning indicators through the process of analyzing and then describing errors in Software Engineering class XI students at a Vocational High School in the city of Kabupaten Bandung Barat. This research can be a reference for practitioners to find out students' responses to the application of students' mathematical reasoning abilities in quadratic equation material.

METHOD

Data collection uses a descriptive method with a qualitative approach. The qualitative descriptive research method according to Yuliani (2018) is a qualitative approach with an inductive flow as a research method, starting with an event and ending with concluding. The research subjects used were 15 students of class XI Software Engineering at a Vocational High School in the city of Kabupaten Bandung Barat. This research consists of three stages, namely planning, implementation, and reporting. In the planning stage, the researcher conducted permits for the school concerned and made three essay test items. In the implementation phase, the researcher gave a description test to students. Finally, in the reporting stage, the researcher processes the data and compiles it in the form of a report. The following is a percentage of students' mathematical reasoning abilities.

Table 1. Average Student Ability Category

Percentage	Category
$0\% \leq P < 20\%$	Very Low
$20\% \leq P < 40\%$	Low
$40\% \leq P < 60\%$	Currently
$60\% \leq P < 80\%$	Hight
$80\% \leq P < 100\%$	Very Hight

(Modification Romika & Amalia (2018))

Students' mathematical reasoning abilities are classified into five categories, namely very low, low, medium, high, and very high. Table 1 is useful for viewing the percentage of students' average ability in the description test. Besides that, it can be used to make it easier for researchers to interpret the results of the analysis of the acquisition of scores.

Table 2. Average Student Ability Category

Question Indicator	Answer Details	Score
Inductive reasoning: making predictions	No answer	0
	Identify the process on the question given and determine the approximate way to solve it	0-2
	Develop approximate answers that are relevant to the question	0-2
Deductive reasoning: prove directly	Develop a mathematical model of the questions given	0-3
	Carry out the settlement process according to the relevant way to get the right answer	0-3
	Make conclusions in the form of ordinary sentences	0-2
	Total score of one test item	0-12

(Modification Hendriana & Soemarmo (2019))

Based on Table 2 the indicators of students' mathematical reasoning abilities consist of inductive and deductive. In this study, one item includes inductive and deductive assessment.

The scoring in this study refers to the school's minimum completeness criteria of 75. Students' abilities are grouped into three categories, namely students with high abilities ($x > 75$), moderate ($60 < x \leq 75$), and low ($x \leq 60$) (Ronny et al., 2022).

RESULTS AND DISCUSSION

Results

After the research was conducted on 15 students using three description questions, data were obtained on the percentage of the average student's ability when solving quadratic equation problems.

Table 3. Student Score Percentage Results

Value Range	The Number of Students	Category	Percentage
$x > 75$	3	Hight	20%
$60 < x \leq 75$	6	Currently	40%
$x \leq 60$	6	Low	40%

The results of the calculations in Table 3 show that 3 students have high abilities, 6 students have moderate abilities, and 6 students have low abilities. This means that there are still many students who have not been able to complete the essay test properly as evidenced by 40% of students with moderate abilities and 40% of students with low abilities.

Table 4. Results of Student Error Analysis in Solving Quadratic Equation Problems

Question Indicator	Percentage	Category
Inductive reasoning: making predictions	25%	Low
Deductive reasoning: prove directly	41.67%	Currently

The results of the calculations in Table 4 show that the percentage of student errors in the inductive reasoning indicator by estimating 25% is in the low category. Meanwhile, student errors in deductive reasoning indicators by proving directly amounted to 41.67 in the moderate category. Error in number 1 is that all students do not make the set of solutions correctly (can be seen in figure 1). Error in number 2 is that most students are not able to interpret the problem properly so that there is a mistake in solving the problem (can be seen in figures 2 and 3). Finally, the error in number 3 is that students are unable to interpret the questions and change the distance units, this can happen because students are not careful in reading the questions (can be seen in figures 4 and 6).

The following is a sample of student answer errors for each of the questions given.

Jawab

$$\begin{aligned}
 1. a. \quad & 3x - x^2 + 10 = 0 \\
 & -3x + x^2 - 10 = 0 \\
 & x^2 - 3x - 10 = 0 \\
 & x^2 + 2x - 5x - 10 = 0 \\
 & x \cdot (x+2) - 5(x+2) = 0 \\
 & (x+2) \cdot (x-5) = 0 \\
 & x+2 = 0 \\
 & x-5 = 0 \\
 & x = -2 \\
 & x = 5
 \end{aligned}$$

Figure 1. Student's Answer Error in Number 1

Question number 1 is to determine the solution set of the equation $3x - x^2 + 10 = 0$. The correct answer to the mathematical equation is the set of solutions $\{-2, 5\}$ or $\{5, -2\}$. All students did not write down the set of solutions after knowing the value of the coefficient x . From Figure 1 it can be seen that the students were not careful in making conclusions in the form of ordinary sentences after knowing the value of the x coefficient.

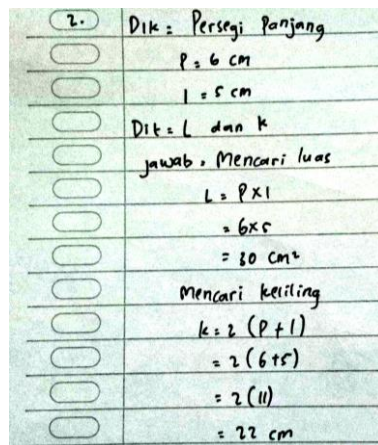


Figure 2. Student's Answer Error in Number 2

Question number 2, that is, it is known that a rectangle has a length of 6 cm and a width of 5 cm. If each of these measurements is extended by x cm, then the area of the rectangle is tripled. Determine the value of the x. Figure 2 shows that students are still wrong in making estimates of the interpretation of the questions. So there was an error in solving the problem. The correct answer to question number 2 is shown in Figure 3.

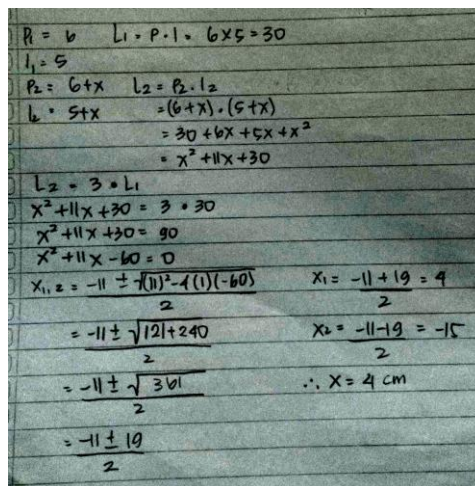


Figure 3. Correct Student Answers to Number 2

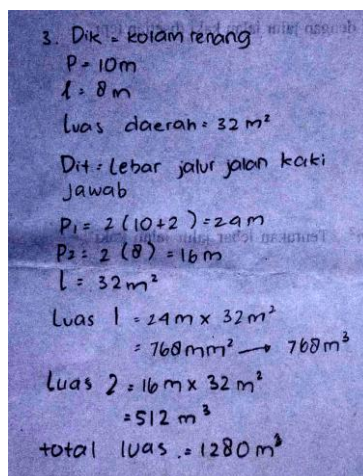


Figure 4. Student's Answer Error in Number 3

Question number 3: It is known that a rectangular pool is surrounded by walking paths on each edge of the pool, as shown in the following figure.

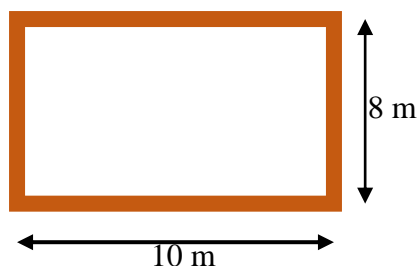


Figure 5. Illustration of Problem Number 3

If it is known that the area of the shaded region is 32m^2 . Determine the width of the walkway. Figure 4 shows that students are still wrong in making estimates of the interpretation of the questions and wrong in stating the unit of measure of distance in area 1 results. The correct answer to question number 3 is shown in Figure 6.

$$\begin{aligned}
 3) \quad L_1 &= p \times l = 10 \times 8 = 80 \\
 L_2 &= p \times l = (10 + 2x)(8 + 2x) = 32 \\
 80 - 20x - 16x + 4x^2 &= 32 \\
 4x^2 - 36x + 80 &= 32, \quad | \quad - \\
 x^2 - 9x + 20 &= 8 \\
 x^2 - 9x + 12 &= 0 \\
 L_2 &= L_1 \\
 x^2 - 9x + 12 &= 80 \\
 x^2 - 9x - 68 &= 0 \\
 x_{1,2} &= \frac{9 \pm \sqrt{81 + 272}}{2} \quad x_1 = \frac{9 + 19}{2} = \frac{28}{2} = 14 \\
 &= \frac{9 \pm \sqrt{353}}{2} \quad x_2 = \frac{9 - 19}{2} = \frac{-10}{2} = -5 \\
 &= \frac{9 \pm 19}{2} \quad \text{Jadi lebar jalan } 19 \text{ m}
 \end{aligned}$$

Figure 6. Correct Student Answers to Number 3

Discussions

Based on the Sobari (2022) adaptation essay test given to 15 students in class XI Software Engineering at a Vocational High School in Kabupaten Bandung Barat, illustrates the number of students who have not been able to complete the quadratic equation description test properly according to indicators of mathematical reasoning ability. In line with that, Rahmawati & Putri (2022) said that students' reasoning abilities were quite good with an average of 61.41 on the mathematical manipulation indicator and checking the accuracy of arguments. Not being thorough in understanding the problem is an external factor of haste in working on the problem and accuracy (Anugrah & Pujiastuti, 2020).

Seeing the number of students who are unable to interpret the problem and determine the solution, it can be said that students' ability to solve problems inductively is influenced by their mastery of exponential equation material as a prerequisite material for quadratic equations (Maifa, 2019). Errors in stating units can be caused by carelessness, firmness in

answering questions, and errors in calculating, so accuracy is needed in answering questions (Daswarman, 2022).

CONCLUSION

Based on the analysis in this study, it can be concluded that the ability of class XI students in Software Engineering at one of the Vocational High Schools in Kabupaten Bandung Barat is still low. This can be seen from some of the students' wrong answers. The results of the analysis can be seen by students' mistakes in answering quadratic equation questions. The accuracy of students towards questions number 1 and number 3 is still low, so it is necessary to do regular exercises. Students' mathematical reasoning abilities need to be honed again. It can be seen from the results of the answers to question 2 that students have not been able to interpret the questions so inductive indicators on students' mathematical reasoning abilities have not been fulfilled. As a result, these students cannot solve the problem correctly, and have a big impact on the value they get.

REFERENCES

- Anugrah, A., & Pujiastuti, H. (2020). Analisis Kesalahan Siswa dalam Menyelesaikan Soal HOTS Bangun Ruang Sisi Lengkung. *Jurnal Pendidikan Matematika*, 11(2), 213–225. <https://doi.org/10.36709/jpm.v11i2.11897>
- Daswarman, D. (2022). Analisis Kesalahan Mahasiswa PGSD dalam Menyelesaikan Soal Matematika. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 6(2), 1335–1344. <https://doi.org/10.31004/cendekia.v6i2.1338>
- Fajriyah, L., Nugraha, Y., Akbar, P., & Bernard, M. (2019). Pengaruh Kemandirian Belajar Siswa SMP Terhadap Kemampuan Penalaran Matematis. *Journal on Education*, 1(2), 288–296. [https://doi.org/Pengaruh kemandirian belajar siswa SMP terhadap kemampuan penalaran matematis](https://doi.org/Pengaruh%20kemandirian%20belajar%20siswa%20SMP%20terhadap%20kemampuan%20penalaran%20matematis)
- Hamdi, S., Suganda, I. A., & Hayati, N. (2018). Developing Higher-Order Thinking Skill (HOTS) Test Instrument Using Lombok Local Cultures as Contexts for Junior Secondary School Mathematics. *REiD (Research and Evaluation in Education)*, 4(2), 126–135. <https://doi.org/10.21831/reid.v4i2.22089>
- Hendriana, H., & Soemarmo, U. (2019). *Penilaian Pembelajaran Matematika* (N. F. Atif (ed.); Cetakan Ke). PT Refika Aditama.
- Maifa, T. S. (2019). Analisis Kesalahan Mahasiswa dalam Pembuktian Transformasi Geometri. *Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika (JRPIPM)*, 3(1), 8–14. <https://doi.org/10.26740/jrpipm.v3n1.p8-14>
- Mutiarani, A., & Sofyan, D. (2022). Kemampuan Komunikasi Matematis Siswa pada Materi Persamaan dan Fungsi Kuadrat Berdasarkan Gender di Desa Sukamenak. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu*, 1(1), 1–14. <https://doi.org/10.31980/powermathedu.v1i1.1911>
- Rahmawati, S., & Putri, R. I. I. (2022). Penalaran Matematis Siswa dalam Pembelajaran Fungsi Kuadrat Menggunakan PMRI dan Collaborative Learning Berbantuan Media Video. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 11(1), 577–588. <https://doi.org/10.24127/ajpm.v11i1.4622>
- Rohaeti, E. E., Putra, H. D., & Primandhika, R. B. (2019, October). Mathematical Understanding And Reasoning Abilities Related To Cognitive Stage Of Senior High School Students. In *Journal of Physics: Conference Series* (Vol. 1318, No. 1, p. 012099).

IOP Publishing.

- Romika, R., & Amalia, Y. (2018). Analisis Kemampuan Pemecahan Masalah Matematika Siswa pada Materi Bangun Ruang Sisi Datar dengan Teori Van Hiele. *Bina Gogik: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, 1(2). <https://doi.org/10.25217/numerical.v3i1.477>
- Ronny, R. T., Amelia, R., & Bernard, M. (2022). Analisis Kesalah Siswa dalam Menjawab Soal Lgika Matematika Pada Indikator Berpikir Kritis Matematis. *JPMI (Jurnal Pembelajaran Matematika Inovatif)*, 5(2), 559–566. <https://doi.org/10.22460/jpmi.v5i2.10208>
- Saraswati, P. M. S., & Agustika, G. N. S. (2020). Kemampuan Berpikir Tingkat Tinggi dalam Menyelesaikan Soal HOTS Mata Pelajaran Matematika. *Jurnal Ilmiah Sekolah Dasar*, 4(2), 257–269. <https://doi.org/10.23887/jisd.v4i2.25336>
- Senjayawati, E., & Nurfauziah, P. (2018). Peningkatan Kemampuan Penalaran Matematik dan Self Efficacy Siswa SMK dengan Menggunakan Pendekatan Creative Problem Solving. *Jurnal Ilmiah P2M STKIP Siliwangi*, 5(2), 117–129.
- Siahaya, J. A., Ayal, C. S., & Ngilawajan, D. A. (2021). Analisis Kemampuan Penalaran Matematis Siswa Pada Materi persamaan Kuadrat. *Science Map Journal*, 3(1), 1–18. <https://doi.org/10.30598/jmsvol3issue1pp1-18>
- Sobari, A. S. (2022). *Learning Obstacle pada Materi Persamaan Kuadrat Ditinjau dari Gaya Belajar Siswa* [Universitas Pendidikan Indonesia]. <http://repository.upi.edu/id/eprint/87268>
- Sumartini, T. S. (2015). Peningkatan Kemampuan Penalaran Matematis Siswa Melalui Pembelajaran Berbasis Masalah. *Mosharafa: Jurnal Pendidikan Matematika*, 4(1), 1–10. <https://doi.org/10.31980/mosharafa.v5i2.270>
- Sumayanthi, I. G. A. W. (2021). Penerapan Pendekatan Kontekstual Berbantuan Media Konkret Untuk Meningkatkan Aktivitas dan Hasil Belajar Matematika Bagi Siswa Kelas IV Semester I Sekolah Dasar Nomor 2 Bongkasa Tahun Ajaran 2019/2020. *Jurnal Pendidikan Dasar Rare Pustaka*, 3(1), 27–37. <https://doi.org/https://doi.org/10.23887/ijee.v1i2.11601>
- Supardi, S. (2022). Penerapan Model Pembelajaran Problem Based Learning pada Persamaan dan Fungsi Kuadrat untuk Meningkatkan Hasil Belajar Peserta Didik di Kelas XI TIA SMKN 2 Bogor. *JPG: Jurnal Pendidikan Guru*, 3(1), 22–29. <https://doi.org/10.32832/jpg.v3i1.6600>
- Wanti, N., Juariah, J., Farlina, E., Kariadinata, R., & Sugilar, H. (2017). Pembelajaran Induktif pada Kemampuan Penalaran Matematis dan Self-Regulated Learning Siswa. *Jurnal Analisa*, 3(1), 56–69. <https://doi.org/10.15575/ja.v3i1.1497>
- Wau, H. A., Harefa, D., & Sarumaha, R. (2022). Analisis Kemampuan Penalaran Matematis pada Materi Barisan dan Deret Siswa Kelas XI SMK Negeri 1 Toma Tahun Pembelajaran 2020/2021. *Afore: Jurnal Pendidikan Matematika*, 1(1), 42–50.
- Wicasari, B., & Ernaningsih, Z. (2016). Analisis Kemampuan Berpikir Siswa dalam Menyelesaikan Permasalahan Matematika yang Berorientasi Pada HOTS. *Prosiding Seminar Nasional Reforming Pedagogy*, 1(2017), 249–254.
- Yuliani, W. (2018). Metode Penelitian Deskriptif Kualitatif dalam Perspektif Bimbingan dan Konseling. *Quanta*, 2(2), 83–91. <https://doi.org/https://doi.org/10.22460/q.v2i2p83-91.1641>