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Learning Obtacles for Junior High School Students on The Concept of Quadratic Equations

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Abstract

This research aims to identify the learning obstacles faced by students in the topic of quadratic equations. The data for this study were obtained through tests and interviews. A qualitative research method with a hermeneutic phenomenology design was employed. The study involved 30 ninth-grade students from a junior high school in Banjar Regency, South Kalimantan. Several learning obstacles were experienced by students in the concept of quadratic equations, namely: 1) ontogenic obstacles occur due to students' inability to grasp the concept of quadratic equations. This is caused by a mismatch between the learning or knowledge intended to be constructed by students and their thinking abilities; 2) Didactical obstacles arise from the lack of coherence in the material, both in terms of the interconnectedness of quadratic equation concepts and the continuity of the thinking process, as well as the presentation of less-detailed materials; 3) Epistemological obstacles occur because students' knowledge related to quadratic equations is limited to specific contexts only.

Keywords: Student errors, Learning obstacle, Quadratic equation

Abstrak

Penelitian ini dimaksudkan untuk mengidentifikasi *learning obstacle* yang dihadapi oleh siswa pada materi persamaan kuadrat. Data dipenelitian ini diperoleh melalui tes dan wawancara. Metode penelitian yang digunakan adalah metode kualitatif dengan desain fenomenologi hermeneutik. Penelitian ini melibatkan 30 siswa kelas IX di salah satu SMPN di Kabupaten Banjar, Kalimantan Selatan. Terdapat beberapa *learning obstacle* yang dialami siswa pada konsep persamaan kuadrat, yaitu: 1) *ontogenic obstacle* terjadi karena ketidakmampuan siswa memahami konsep persamaan kuadrat. Hal ini diakibatkan oleh ketidaksesuaian pembelajaran atau pengetahuan yang hendak dikontruksikan siswa dengan kemampuan berpikirnya; 2) *didactical obstacles* terjadi karena ketidakrunutan materi baik secara keterkaitan antar konsep persamaan kuadrat ataupun secara kesinambungan proses berpikir dan secara penyajian materi yang kurang terperinci; 3) *epistimological obstacle* terjadi karena pengetahuan siswa terkait persamaan kuadrat hanya terbatas pada konteks tertentu saja.

Kata kunci: kesalahan siswa**,** *Learning obstacle*, persamaan kuadrat

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INTRODUCTION

In the Indonesian education curriculum, mathematics is one of the compulsory subjects taught at schools for every level of education. Mathematics is a field of study that holds a significant role in education. This can be observed from the greater number of class hours dedicated to mathematics compared to other subjects. Despite having more class hours, the reality indicates that mathematics is still perceived as daunting, difficult, and uninteresting by some students. Consequently, there is a lack of motivation to participate in mathematics classes, resulting in an impact on students' learning achievements. Mathematics lessons should not merely be presented as exercises in memorizing formulas and definitions; rather, emphasis should be placed on the ability to comprehend problems and apply mathematical concepts to solve real-life situations. This is also consistent with the findings of Aini et al., (2020) that conceptual understanding can help students remember and facilitate their problem-solving in mathematics. Additionally, Kilpatrick et al., (2001) also define conceptual understanding of mathematics as an integrated and functional understanding of mathematical ideas. Students with conceptual understanding are aware of more isolated facts and methods. They are able to organize their abilities into a coherent whole, allowing them to learn new ideas by connecting these ideas with what they already know.

Based on the 2013 curriculum, one of the mathematics topics taught to ninth-grade students is quadratic equations. *of*ten, during classroom instruction, it is observed that some students still struggle to understand this topic (Anggraini & Kartini, 2020). According to Putri (2019), quadratic equations are equations in which the highest power is 2. In the topic of quadratic equations, students are usually required to find the roots of the equations. In this topic, students are expected to comprehend the coefficients, variables, and constants within a quadratic equation. Anggraini & Kartini (2020), suggests that quadratic equations are considered difficult by students. This is supported by interviews conducted with mathematics teachers at SMPN 2 Bangkinang Kota. As a result, students often make mistakes in solving problems related to quadratic equations.

This indicates the presence of learning barriers that need to be further analyzed. It is important to analyze the characteristics of the learning obstacles experienced by students in this subject. With a deep understanding of the learning barriers faced by students, teachers can design appropriate treatments or actions. This may involve improving the delivery of the material by teachers through the implementation of specific teaching models or methods, or developing teaching materials that better suit the students' needs. In line with Gulvara et al., (2023), who stated that analyzing students' learning obstacle is a crucial step in understanding their difficulties in learning mathematics. This is because learning difficulties can lead to mistakes made by students during the learning process (Tamba & Siahaan, 2020). Students' learning difficulties can be detected through the emergence of errors made by students when solving mathematical problems (Farida, 2015). By knowing the errors and the factors causing them, teachers can minimize and even address students' misconceptions in solving mathematical problems.

This research will further discuss the learning obstacles that occur in students when solving problems related to plane geometry. In this study, learning obstacles will be categorized into three types based on the concepts proposed by (Brousseau, 2002). First, ontogenic obstacles refer to the mismatch between the provided learning and the students' thinking level. This can lead to difficulties in understanding the material. If the learning provided is too low or does not align with the students' thinking level, the students' learning process will not be optimal. Conversely, if the learning provided is too advanced, students may struggle and possibly lose interest in learning mathematics. Second, epistemological obstacles arise from the limited understanding of concepts held by students. Students may only grasp concepts partially, resulting in difficulties when applying them in different contexts. For example, students may understand the concepts of squares and rectangles separately, but they may struggle to identify and apply these concepts in real-life situations. Third, didactical obstacles stem from the teaching methods employed by the teacher. Factors such as ineffective teaching methods, lack of variation in instruction, or the use of inappropriate teaching materials can hinder students' understanding and problem-solving in mathematics.

Through this research, the characteristics of learning obstacles experienced by students when solving problems related to quadratic equations will be further analyzed. By comprehensively understanding the learning barriers faced by students, teachers can provide more effective assistance in improving students' understanding of mathematical problem-solving in the topic of quadratic equations.

METHOD

Based on the objectives of this research, a qualitative approach is employed, which is a method used for exploring and understanding the meaning of social or human issues through various processes such as posing questions, collecting data, analyzing data, and interpreting data (Creswell, 2010). This research is grounded in an interpretive paradigm, which examines phenomena related to the impact of didactic design on an individual's thinking process (Suryadi, 2019). In other words, the design applied in this research is phenomenological hermeneutics, utilizing the Didactical Design Research (DDR) framework. The aim of this study is to obtain in-depth data regarding the learning obstacles experienced by 30 ninth-grade students in the topic of quadratic equations at one of the junior high schools in Banjar Regency, South Kalimantan.

In the initial stage of the research, the author developed a set of three open-ended problems on quadratic equations. Open-ended problems were chosen because they can assess students' mental processes in expressing their ideas in their answers. After the problem set was prepared, it was given to the students. Subsequently, the author conducted interviews to gather additional information regarding the learning obstacles experienced by the students. Finally, in the last stage, the author analyzed all the collected data in this study using the triangulation method.

RESULTS AND DISCUSSION

The author provided three problems related to the concept of quadratic equations. These problems were designed to assess the learning obstacles faced by students regarding the concept of quadratic equations. From the three given problems, a variety of answers were obtained for each problem, as follows:

The variety of students' responses in solving problem number 1

Here is the first problem used to identify learning obstacles in the topic of quadratic equations:

The solution to the equation $x^2 = 3x + 4$ *is ….*

From the data of students' answers to question number 1, it can be observed that some students are able to solve the quadratic equation in the question correctly. However, there are still some errors made by students in solving this problem. Based on the students' answers, two types of responses are identified. Students with Type 1 responses provide the correct solution to the quadratic equation, while students with Type 2 responses provide incorrect solutions to the quadratic equation.

Type 2 responses identify errors made by students in determining the solution to the quadratic equation. *on*e of the common mistakes observed is that students incorrectly transform the equation $x^2 = 3x + 4$ from the given question into the standard form of a quadratic equation $ax^2 + bx + c = 0$, Instead, students write the equation as $x^2 + 3x + 4 = 0$, which leads to errors in determining the values of a, b, and c. Consequently, when using the quadratic formula to find the solutions, students obtain incorrect results. The student's response is shown in Figure 1.

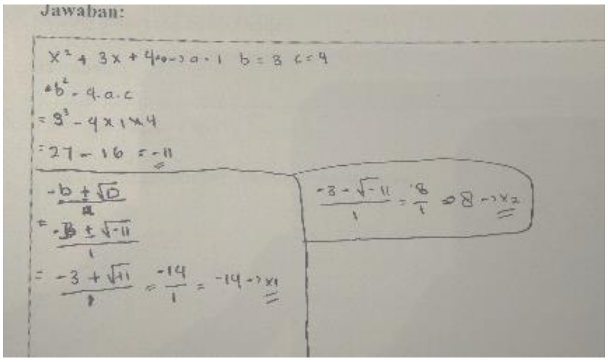

Figure 1. Student's error in problem number 1

Below are the results of an in-depth interview with the student regarding their answer above.

P : “from problem number 1, can you explain how you arrived at your answer $x^2 + 3x + 4 = 0$?”

S : “Yesterday, I made a mistake in transferring the terms. It should have been $x^2 - 3x - 4 = 0$ right? Im followed the general form of $ax^2 + bx + c$”

Based on the student's response, it appears that the student is aware of the general form of a quadratic equation. However, when presented with an equation that deviates from the general form, the student struggles to solve it. Through an in-depth interviews with students, it was discovered that the students made a mistake or forgot how to perform the operation of "moving terms" in an equation. The students misunderstood the purpose of the operation, viewing it as a way to transfer a value from one side of the equation to the other. However, the true intention of the operation of moving terms in mathematics is to add, subtract, divide, or multiply both sides of the equation by the same number, resulting in an equivalent equation. Therefore, the cognitive inability of the students to interpret this concept in the problem, according to Brousseau (2002) and Suryadi (2019) categorized as an ontogenic conceptual obstacle.

Figure 2. Student's attempt to find a solution to the equation $x^2 = 3x + 4$ by substituting possible values. The student found that x=4 satisfies the equation but only searched for one solution.

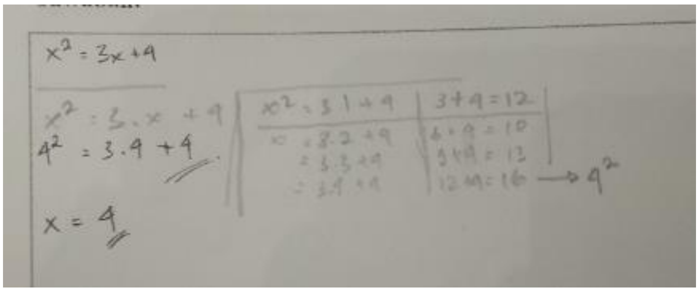

Figure 2. Student's error in problem number 1

Below are the results of an in-depth interview with the student regarding their answer above.

P : "Which method do you usually use?"

S : "I often use factoring and the ABC formula because completing the square method was not taught in class."

P : "*and* how about the ABC formula? Do you remember it?"

S : “The student mentions $x_{1,2} = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$.”

P : “See, you remember it. Why didn't you use that method before?”

S : “I'm more accustomed to solving equations using logic, so I wasn't familiar with using the existing formula”

P : “Then, can you explain why the solution to this equation is only $x = 4$?”

S : “I don't know, I wasn't aware that there could be two values for x.”

Based on the in-depth interview with the student, as mentioned in the above dialogue, it is evident that the student mistakenly believed that the equation only had one solution. The student was unaware that the equation actually had two roots or solutions. Although the student knew about methods for solving quadratic equations such as factoring and the quadratic formula, they did not use those methods because of their limited proficiency. It is known that the student has learned about the properties of roots and methods for solving quadratic equations, but their response indicates a lack of complete mastery of the concept. Therefore, the student's inability to fully grasp the concept of quadratic equations results in an *on*togenic Conceptual Obstacle.

In figure 3, it can be observed that the student made an error in the method used to solve the equation $x^2 = 3x + 4$. The student attempted to use the relationship between the roots of a quadratic equation, $x_1 + x_2$ dan $x_1 \times x_2$ to find the solution to the quadratic equation. As a result, they were unable to find the correct solution. However, it should be noted that the student had previously learned about methods for solving quadratic equations, such as factoring and the quadratic/abc formula.

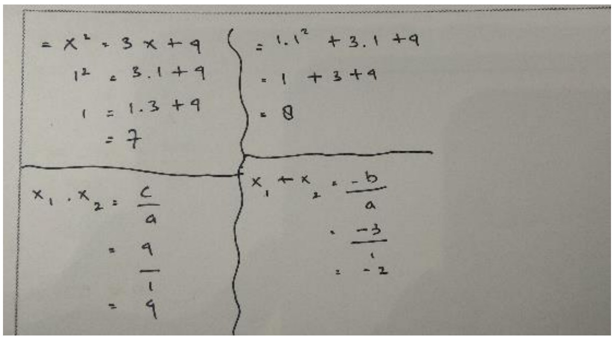

Figure 3. Student's error in problem number 1

Below are the results of an in-depth interview with the student regarding their answer above

P : "Have you learned methods for solving quadratic equations?"

S : “Yes, I have."

P : "Okay, for problem number 1, which method did you use?"

S : "I used the formulas for finding the sum of roots ($x_1 + x_2$) and the product of roots ($x_1 \times x_2$). I wasn't sure which method to use, so I used those formulas."

Through an in-depth interview with the student based on dialogue 4.4 above, it is revealed that the student has learned the methods for solving quadratic equations. However, when faced with a slightly different problem, the student becomes confused about which formula to use. As a result, the student makes errors in applying the formula and obtains incorrect results. It is known that the student has learned about the properties of roots and methods for solving quadratic equations, but their response indicates a lack of complete mastery of the concept of quadratic equations. Therefore, the students' inability to master the previous material, according to Brousseau (2002) and Suryadi (2019), will result in students experiencing a hindrance known as *on*togenic Conceptual Obstacle.

In the responses to question 1, no students were found to solve the problem using the completing the square method. In Figure 4 below, it can be observed that the students only utilized factoring and the quadratic formula to solve the problem.

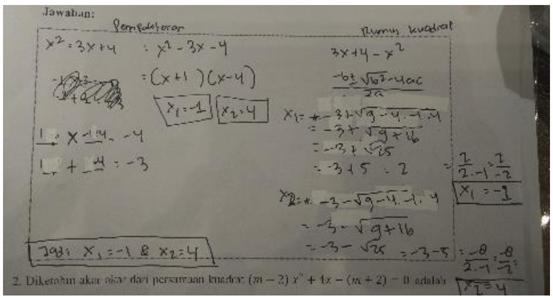

Figure 4. Student's error in problem number 1

Below are the results of an in-depth interview with the student regarding their answer above.

P : "Alright, let's look at problem number 1 first. Here, you solved the equation using factoring and the quadratic formula. Can you also solve it using the method of completing the square?"

S : "Hmm, I can't, sorry."

P : "Why can't you?"

S : "The method of completing the square wasn't explained by the teacher in class, so I don't understand it."

P : "I see. So it wasn't explained. How about the quadratic formula? Were you taught how to derive or obtain the formula?"

S : "No, we weren't taught that either. We were only taught how to use the formula, so the focus was on substituting the known values into the formula."

Based on the interview results with the students from the above dialogue, it is known that even though the method of completing the square is presented in the textbook, it was not taught by the teacher in class. The teacher only taught two methods of solving quadratic equations, namely factoring and the quadratic formula. Thus, the learning obstacle arising from students' limited knowledge of quadratic equations due to classroom learning processes that do not align with curriculum demands, according to Brousseau (2002), is categorized as a didactical obstacle. Furthermore, most students could provide answers but were unable to explain why they chose a particular method. It is evident that students only learned from the examples provided in the textbook or taught by the teacher in class. Therefore, in this case, the students experience an epistemological obstacle.

Based on the students' answers to solve question number 1, it is evident that students face difficulties when the given quadratic equation is not in its standard form. Additionally, most students are only able to solve quadratic equations using one method, either factoring or the quadratic formula. This finding aligns with previous research conducted by Ruli (2021), which states that many students tend to solve quadratic equations using only one approach.

The variety of students' responses in solving problem number 2

The second question used to identify learning obstacles in quadratic equations.

Given that the roots of the quadratic equation $(m-2)x^2+4x+(m+2)=$
$are\ \alpha\ and\ \beta. If\ \alpha.\beta^2+\beta.a^2=-20.$ *then the value of m is...*

Problem number 2 is related to finding a value in a quadratic equation using the relationship between the roots of the quadratic equation. Based on the students' answers, two types of responses were identified. Students with type 1 answers provided the correct value of m in the quadratic equation, while students with type 2 answers provided incorrect values for m in the quadratic equation. Type 2 answers indicate errors made by students in finding the solutions of the quadratic equation, including the common difficulty among students in distributing $\alpha.\beta^2+\beta.a^2$. Students were only able to expand $\alpha.\beta^2+\beta.a^2$ to $\alpha\beta\beta+\alpha\alpha$ and were unable to continue the process to obtain $(\beta+\alpha)(\alpha\beta)$. As a result, students were unable to substitute the values of (β+α) and (αβ) obtained from the previous steps. Consequently, students were unable to complete the solution to the problem. The student's response is shown in Figure 5.

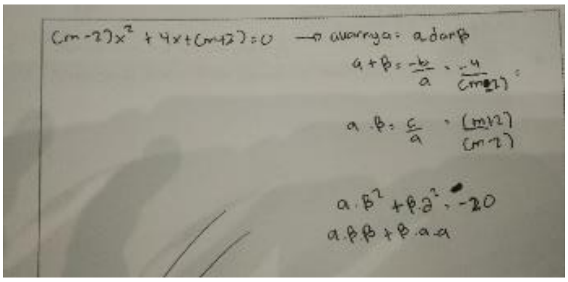

Figure 5. Student's error in problem number 2

Below are the results of an in-depth interview with the student regarding their answer above.

P : “Distributing $\alpha\beta^2 + \alpha^2\beta = -20$ results in the form $(\alpha + \beta)(\alpha \times \beta) = -20$ ya?

S : “Yes, because I forgot the process, and what I had was just $\alpha.\beta.\beta + \alpha.\alpha.\beta$, and I couldn't assign any values to it. So, my answer only reached that point.”

Based on the interview results from the above dialogue, it is evident that students struggled with distributing $\alpha\beta^2 + \alpha^2\beta$, even though this topic was covered prior to quadratic equations. It is known that students did not fully grasp the prerequisite material before quadratic equations, as their response indicates partial recollection but not complete understanding. Therefore, the students' inability to master the previous material, according to Brousseau (2002) and Suryadi (2019), will result in students experiencing a hindrance known as a conceptual ontogenic obstacle.

In addition, the students also forgot the formula for the relationship between the roots of a quadratic equation. As a result, the students attempted to solve the problem by substituting $m = 40$ into the equation $(m-2)x^2 + 4x + (m+2) = 0$. The student's response is shown in Figure 6.

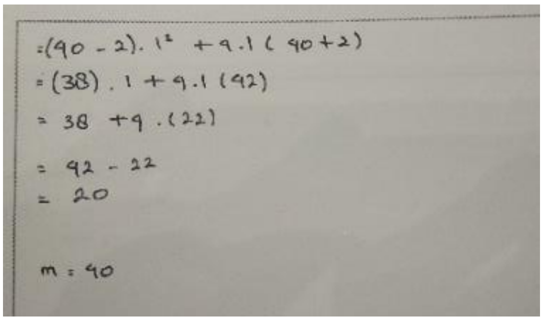

Figure 6. Student's error in problem number 2

Below are the results of an in-depth interview with the student regarding their answer above.

S : "I'm confused with all the numbers and letters in this (pointing to problem number 2). Plus, I forgot the formula to solve it. So, I just tried different approaches."

P : "Alright, you forgot it yesterday. Now, let's review it. According to you, which formula should be used in this case?"

S : “using $x_1 + x_2 = -\frac{b}{a}$”

P : “Yes, that's correct. It uses the formula $x_1 + x_2 = -\frac{b}{a}$ and $x_1 \times x_2 = \frac{c}{a}$ or the property of the relationship between quadratic equations. Can you simplify or distribute the expression $a\beta^2 + \alpha^2\beta = -20$?"

S : "No, I can't, I forgot how to do it."

Based on the interview results from the above dialogue, student forgot the formula for the relationship between the roots of a quadratic equation, which hindered them in solving the problem. However, the formula for the relationship between the roots of a quadratic equation is a topic that has been taught in quadratic equation lessons. Furthermore, the student also faced difficulties in factoring aβ^2+α^2 β=0. Based on the student's response, it indicates that the student does not fully grasp the concept of quadratic equations. Therefore, the students' inability to fully understand the concept of quadratic equations, particularly regarding the relationship between the roots of quadratic equations, according to Brousseau (2002) and Suryadi (2019), will result in students experiencing a hindrance known as a conceptual ontogenic obstacle.

Furthermore, the problem presented in question number 2 is rarely encountered by students. This is because students often learn through examples provided in textbooks or based on explanations given by the teacher. During the learning process, the teacher usually focuses on demonstrating how to apply or use the formulas without providing in-depth explanations. Therefore, the limited context known to students regarding quadratic equations becomes an obstacle for them, known as an epistemological obstacle.

Based on the answers and interviews with the student, it is known that the student experienced difficulty in distributing $\alpha.\beta^2 + \beta.a^2$ toi $(a+\beta)(a.\beta)$ leading to mistakes in the process. Additionally, question number 2 is considered uncommon for students, causing some of them to try solving it based on their own understanding.

The variety of students' responses in solving problem number 3

The third question used to identify learning obstacles in quadratic equations.

Dinda bought oranges and mangos at the Floating Market Lok Baintan. The total number of oranges and mangos bought by Dinda is equal to 40 fruits. If the product of oranges and mangos is equal to 300 fruits. Determine the possible quantities of each fruit bought by Dinda.

Question number 3 is a quadratic equation problem presented in the form of a story. In this question, students are expected to translate the story into mathematical sentences. Based on the students' answers, two types of responses were found. Type 1 represents correct answers in solving the quadratic equation story problem, while Type 2 represents incorrect answers in solving the quadratic equation story problem.

Type 2 responses indicate some common mistakes made by students, such as using their own reasoning in solving the problem and struggling to translate the story into mathematical sentences.

Additionally, students still struggle to represent the given information in the problem as a quadratic equation.

The errors made by students in solving question number 3 are shown in Figure 8. The students were able to assign variables x and y to oranges and mangos, respectively. However, they were unable to create a mathematical model in the form of a quadratic equation for the given problem. In their attempt to find the values that satisfy the equation, the students tried to find factors of 300 that, when added, result in 40 and, when multiplied, result in 300.

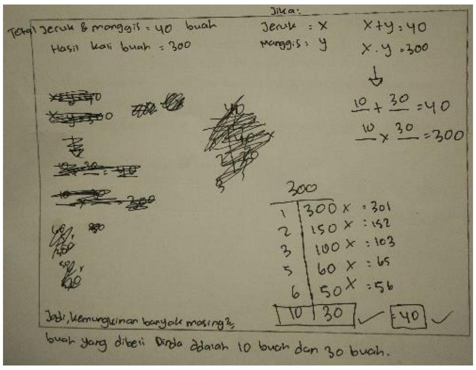

Figure 7. Student's error in problem number 3

Below are the results of an in-depth interview with the student regarding their answer above.

P : “Alright, I see. If you were asked to solve this problem using quadratic equations, would you be able to do it? *and* can you create a mathematical model in the form of a quadratic equation?"

S : "Hmm, yeah, I can do it if I have the equation."

P : "I see. So, you're facing difficulties in modeling this problem into a quadratic equation, right?"

S : "Yes, that's correct."

Based on the interview results from the above dialogue, students face difficulties in modeling the problem into a quadratic equation. The topic related to mathematical modeling in quadratic equations has been taught previously, but the students' answers indicate that they do not fully grasp the concept. Therefore, the students' inability to master the previous material effectively, according to Brousseau (2002) and Suryadi (2019), will result in students experiencing a hindrance known as a conceptual ontogenic obstacle.

In addition, the problem presented in question number 3 is a rarely encountered problem for students. This is because students only learn through examples given in textbooks or based on what the teacher has explained. However, during the learning process, the teacher only explains how to apply or use the given formulas without providing a thorough explanation. Therefore, the limited context known to students regarding quadratic equations, according to Brousseau (2002) and Suryadi (2019), will result in students experiencing a hindrance known as an epistemological obstacle.

Discussion

The learning process and the didactic situation created by the teacher play a crucial role in students' acquisition of knowledge (Lalaude-Labayle et al., (2018) & Suryadi, (2008)). However, there are instances where the didactic situation created by the teacher may not align with students' needs and can potentially lead to learning difficulties experienced by students. These learning difficulties give rise to learning obstacles. According to Brousseau (2002), learning obstacles are part of knowledge or conceptions, and they are not defined as a lack of knowledge resulting in incorrect responses. Brousseau (2002) categorizes learning obstacles into three types: 1) ontogenic obstacle, 2) didactical obstacle, and 3) epistemological obstacle (Bakar et al., 2019).

The test on learning obstacles administered to students consists of three questions related to quadratic equations. The purpose of the test is to identify the learning obstacles experienced by students. The following table provides a summary of the learning obstacles encountered by students during the learning of quadratic equations (Table 1).

Table 1.Learning obstacles faced by students in learning quadratic equations.

Obstacle Type	**Information**
ontogenic Obstacle	1. The students do not understand the concept of quadratic equations. 2. The students do not understand the distributive property. 3. The students have a misunderstanding of the general form of quadratic equations. 4. The students do not understand how to determine the solutions. .
Didactical Obstacle	1. The learning materials used, such as the textbook, do not adequately facilitate the needs and characteristics of the students. 2. The large number of students leads to a lack of optimal interaction in the learning process. 3. The direct provision of solution methods for quadratic equations to students without deeper explanations. 4. Students face difficulties in solving quadratic equations due to a lack of explanations from teachers regarding the use of different methods. 5. The provided questions tend to be repetitive and solely derived from the students' textbook.
Epistemological Obstacle	1. Students do not understand the concept of quadratic equations. 2. Students do not understand the method of solving quadratic equations using completing the square. 3. Students have misunderstandings in comprehending the form of quadratic equations.

Suryadi (2013) divides *on*togenic Obstacles into three categories: psychological ontogenic obstacles related to students' lack of motivation and interest in the studied material, instrumental ontogenic obstacles related to students' lack of technical readiness that is key to the learning process, and conceptual ontogenic obstacles related to students' previous learning experiences, such as a lack of mastery of basic concepts or prerequisite knowledge. Based on the findings of this study and referring to the above, the researcher identified several errors made by students in problem-solving processes. According to the findings, many students were only able to solve quadratic equation problems using one method, either the quadratic formula or factoring method. Some students also made mistakes in the problem-solving process by not following the correct steps and instead guessing the possible calculations. Furthermore, some students were unable to transform quadratic equations into their general forms. Additionally, when determining the solutions to the given quadratic equation, some students were unable to present them in set notation, while others only wrote one solution instead of both.

According to Suryadi (2010) and Brousseau & Warfield (2020), Epistemological Obstacles are hindrances related to limited knowledge confined to specific contexts. Students' limitations in a particular context are caused by their limited understanding of the subject matter and the limitations of the contexts presented in the textbooks they use. Furthermore, based on the previous findings, the learning resources used by students during the quadratic equation learning process were insufficient in facilitating students. Therefore, the learning barrier experienced by students, characterized by their limited knowledge of quadratic equation concepts due to the presentation of material in the mathematics textbook, is categorized as an epistemological obstacle according to Brousseau (2002). This statement is reinforced by previous research that revealed students' acquired knowledge heavily relies on the sequence of tasks provided to them (Fitriati et al., 2020; Henningsen & Stein, 1997). According to Brousseau (2002) and Suryadi (2019), Didactical Obstacles refer to hindrances resulting from errors in the school's instructional system. Didactical obstacles can also arise from a lack of coherence in the material, both in terms of the interrelatedness of concepts and the continuity of thinking processes, as well as insufficient or overly detailed material presentation, Additionally, the didactical obstacle experienced by students may be caused by a lack of meaningful learning in the concept of quadratic equations. According to Ausubel (Ivie, 1998), meaningful learning occurs when the material presented to students is aligned with their existing knowledge..

The findings indicate that students face didactical obstacles, as seen in their answers and interview responses. In question number 1, no students solved the problem using the method of completing the square because they were not taught by the teacher during the learning process. Furthermore, providing solution methods for quadratic equations directly to students without deeper explanations renders the learning less meaningful for them. Students encounter difficulties in solving quadratic equations due to the lack of explanation from the teacher regarding the use of different solution methods. Instead, the teacher merely teaches the application of formulas from the textbook without providing a thorough understanding of how and why those formulas are derived.

When facing learning obstacles, especially in quadratic equations, it is necessary to address them during the learning process to minimize potential hindrances. These obstacles can be addressed through the design of didactic interventions based on students' learning obstacles in quadratic equations. The development of instructional materials based on the findings of students' learning obstacles is one of the objectives of didactic research (Suryadi, 2019). Didactic research involves designing effective learning for students, focusing on the content that needs to be taught and the appropriate methods to teach that content (Suryadi et al., 2016). The design of didactic interventions refers to the theory of didactic situations, which connects knowledge, in this case, school mathematics, with instructional methods (Brousseau, 2002). Therefore, learning through well-designed didactic situations based on the steps of the theory of didactic situations is expected to provide opportunities for students to develop their abstract reasoning abilities and apply them to problem-solving (Suryadi, 2019).

CONCLUSION

Based on the findings and discussions, the following conclusions can be drawn regarding the learning obstacles faced by students in the topic of quadratic equations: 1) Students have a limited understanding of the meaning of quadratic equations and struggle to comprehend their significance. 2) Students are only familiar with one or two methods to solve quadratic equations, lacking exposure to a variety of solution approaches. 3) Students encounter difficulty in translating word problems into mathematical equations or statements. 4) Students struggle to re-represent the given information in a problem into the form of quadratic equations. 5) Students face challenges in solving quadratic equations due to a lack of explanation regarding the use of different solution methods. 6) Students have limited contextual knowledge related to quadratic equations, impacting their ability to apply the concepts effectively.

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