INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
HRMARS MANAGEMENT ACADEMIC RESEARCH SOCIETY EXPLORING INTELLECTUAL CAPITAL
www.hrmars.com
ISSN: 2222-6990

# Analysis of Students' Error in Solving Quadratic Equations Using Newman's Procedure

Daiana Shamini Thomas and Muhammad Sofwan Mahmud

**To Link this Article:** http://dx.doi.org/10.6007/IJARBSS/v11-i12/11760 DOI:10.6007/IJARBSS/v11-i12/11760

***Received:*** *17* October *2021,* ***Revised:*** *20* November *2021,* ***Accepted:*** *30* November *2021*

**Published Online:** 19 December 2021

**In-Text Citation:** (Thomas & Mahmud, 2021)

**To Cite this Article:** Thomas, D. S., & Mahmud, M. S. (2021). Analysis of Students' Error in Solving Quadratic Equations Using Newman's Procedure. *International Journal of Academic Research in Business and Social Sciences*, *11*(12), 222–237.



**Vol. 11, No. 12, 2021, Pg. 222 – 237**

**http://hrmars.com/index.php/pages/detail/IJARBSS** | **JOURNAL HOMEPAGE**

**Full Terms & Conditions of access and use can be found at**
http://hrmars.com/index.php/pages/detail/publication-ethics

INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
HRMARS MANAGEMENT ACADEMIC RESEARCH SOCIETY
EXPLORING INTELLECTUAL CAPITAL
www.hrmars.com
ISSN: 2222-6990

# Analysis of Students' Error in Solving Quadratic Equations Using Newman's Procedure

Daiana Shamini Thomas[1] and Muhammad Sofwan Mahmud[2]
Fakulti Pendidikan, Universiti Kebangsaan Malaysia, Bangi, Malaysia
Email: sofwanmahmud@ukm.edu.my

**Abstract**
The objectives of this study are to determine the type of errors made by the students when solving the problems related to quadratic equations and to identify the factors that lead students to make these errors in the test. The type of error is based on Newman Error Analysis that includes reading type error, comprehension error, transformation error, process skill error and encoding error. A diagnostic test was used as the instrument of this study and a semi-structured interview was used to identify the causes of students' committing such errors from the perspective of the students themselves. The samples were made up of 30 Form Four students from a secondary school in Malaysia. Data was analysed using descriptive statistic and qualitative content analysis. The findings showed that most students make errors in transformation and comprehension while the number of students who make encoding errors was small and there were no reading errors found. Based on test results, interviews were conducted among three students with different levels of understanding. The main reason students make errors in solving quadratic equations is a lack of understanding of the basic concepts and the learning styles. Teacher and student must understand the importance to eliminate these errors in solving quadratic equation which will give huge impact to the students' learning mathematics in the future.
**Keywords:** Quadratic Equation, Students' Error, Newman Model, Mathematics, Transformation Error

## Introduction

In this era of globalization, the subject of mathematics has become something important to all societies with the advancement of science and technology that has brought a new perception to our lives. In this advanced world of education, mathematics plays an important role where it can be seen through our national education system which makes mathematics a core subject in primary and secondary schools (Hassan et al., 2016). Teaching mathematics is very important for intellectual development. There is no other subject in the curriculum that makes students' brains active like mathematics (Yadav, 2019). Therefore, students should master the concepts in this subject in order to be able to apply the concepts in other subjects or daily life.

Algebra is a branch of mathematics that involves solving equations and inequalities to find an unknown quantity. Algebra is the most abstract part of mathematics that has

correlations with other mathematical topics, such as logarithms, indices, statistics, and calculus (Susac et al., 2014). In the education system in Malaysia, algebra is an important topic in the school mathematics curriculum. The teaching of quadratic equations is a part of algebra, and the teaching of this field in schools has started as early as Form One through the Malaysian School Standard Curriculum (KSSM). Yet, there are still many students who face problems with this topic while in high school. Ideally, students are expected to master the concepts in this topic as they do in lower secondary. However, students continuously make errors on this topic, hence failing to have a strong basis for mathematics subjects at tertiary level (Tendere, 2020).

Students face difficulties in solving problems because they do not master a topic and often make mistakes. Many errors in mathematics have different contexts based on the situations in which they occur, which attribute the error to an inability to answer a problem correctly (Wahab et al., 2014). Students find difficulty in learning mathematics for the reason that they do not understand mathematics at a lower level since mathematics is a structured and tiered or hierarchical science. Even with all the efforts, learning mathematics has been difficult all these years for students and it has been a difficult task to deliver for teachers (Langoban, 2020). Lack of knowledge plays an important role in misconceptions or misunderstandings. This is supported by Shelly and Kiray (2019) who emphasise that misconceptions have been determined as one of the most important barriers to learning mathematics.

Errors made by students in mathematics refer to a variety of factors. However, many errors made by students are due to not understanding the mathematical concepts contained in a question (Huat, 2015). Accordingly, the result of these errors ultimately leads to the root cause of students 'failure to master this topic. The inability to understand and master the topic of quadratic equations well will influence students' interest and motivation, in turn affecting their use of other components that ultimately affect their performance.

The conceptual framework that is used in this study is based on Newman Error Analysis. The Newman's Error Analysis (1977) consists of five types of errors, which are reading, comprehension, transformation, process skills, and encoding (Rohmah & Sutiarso, 2018). According to Newman, when a person attempts to answer a standard mathematics question, that person has to be able to pass over a number of consecutive hurdles (Chusnul et al., 2017). The obstacle is a step or type of error in Newman's Error Analysis.

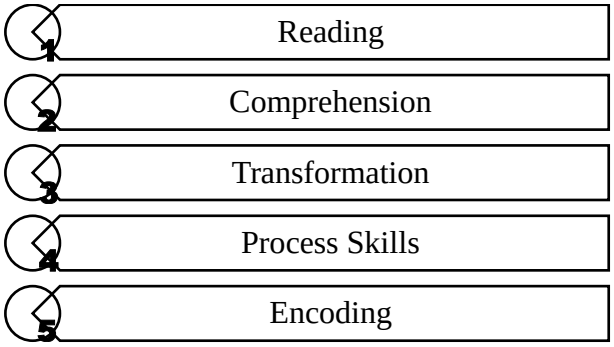



Figure 1 Newman's Error Analysis

Many studies used Newman's Error Analysis to identify the types of error performed mostly by students in solving quadratic equations (Zakaria, 2010; Singh et al., 2010; Makgakga, 2014; Santoso et al., 2017; Faradilla et al., 2019). Reading errors occur when the

student has not mastered basic reading skills. This is the most basic error since the student cannot solve or determine the requirements of the problem-solving question itself. Aulia Rahman (2018) stated that students make mistakes in reading and there is no understanding of the problem well and correctly.

Then, the comprehension error is an error in understanding the need for the question. The students were not able to interpret the questions and the strategies used to manipulate the question were also less precise, in which they failed to solve the following problem (Abdullah et al., 2015). When students are unable to understand the intent of the question, then it is difficult for the student to determine the work process to be performed at the same time, leading to transformation errors (Mahmud et al., 2020). Students make errors in this section when they use the wrong choice of operation, such as when the question requires the performance of a multiplication operation but the student chooses another operation other than multiplication. Transformation error is when students fail to understand the problem to be transformed into the form of mathematical models, and in addition, students cannot determine the right concept or procedure to solve the problem given (Dj Pomalato et al., 2020). In this case, deep understanding of the concept is very important to ensure an appropriate solution to the question.

Next, process skill errors arise when students choose the wrong process that leads to an arithmetic error, procedural error, or incomplete solutions. Pomalato et al (2020) outlined that process skill errors occur when students use rules to solve problems correctly, but make mistakes in computation and computing. Finally, encoding errors occur when the student is able to solve the problem correctly but fails to write the answer correctly or is not accustomed to writing a conclusion after each work on problem solving. An encoding error occurs when the student finishes solving the problem but misinterprets what it meant (Zamzam & Patricia, 2018).

**Problem Statement**

Students will face many obstacles during the teaching and learning process in mathematics because problem solving is a skill that is very complex (Zakaria, 2010). Learning through problem solving requires students to implement the mathematical concepts that have been learned in solving mathematical problems. Therefore, students need to master the topic as it is relevant to other mathematics components such as statistics, quadratic functions, and calculus.

Many students do not master the factoring skills necessary for quadratic expressions because they usually use a scientific calculator to get the answers to the questions involving factorization of quadratic equations (Huat, 2015). Students fail to carry out the important working steps in order to solve the given equation due to the lack of prior knowledge of quadratic concepts such as directed numbers while the common error done by the students is procedural error when using factorisation (Tendere, 2020). Students considered that quadratic equation topic was challenging conceptually, which was proven by Zakaria (2010) that the highest errors made by students were in this topic compared to other mathematics topics, and it was highlighted as the most difficult topic after linear equation word problems (Didis & Erbas, 2015). Mostly, students get confused when quadratic function concepts are presented in different ways that they are not used to (Mutambara et al., 2020). Most students had not mastered the concept of quadratic expression well and were unable to factorise quadratic expressions perfectly (Rosli & Rasdi, 2015).

A few students thought that the use of two variables "x" and "y" or the use of x twice in an equation resulted in a second-degree equation, while others' lack of understanding of the variable concept and determining the degree of a polynomial resulted in confusion between the quadratic equation concept and the linear equation concept (Gözde & Kabar, 2018). It is believed that there are many other factors that influence students to make errors in solving quadratic equations. Thus, it is important to identify the type of errors made by students in solving quadratic equations at an early stage to avoid making the same errors in other related topics. Such challenges and the importance of quadratic equations in the mathematics field have prompted the researchers to conduct a study with the aim of identifying the types of errors that students commit and, subsequently, exploring the reasons they make such errors in order to overcome the learning issues.

**Objective**

This study aims to identify the types of errors made by Form Four students in the topic of quadratic equations and their causes. In particular, the purpose of this study is to identify the types of error that students often make in the topic of quadratic equations and determine the causes of students making such errors in this topic.

**Methodology**

**Data Collection**

The design of this study is a case study with a qualitative approach, and all research questions will be elaborated upon through the instruments managed by the researcher. Cohen et al. (2011) state that a sample is a small group or subset of the population, describing its characteristics. The population for this study is all Form Four students at a selected secondary school in Malacca. A purposive sampling technique was used to select students as samples for this study. A sample of thirty students from Form Four made up the sample in this study.

The researchers used various instruments to collect data. A test with observation was the instrument used to identify errors made by students in solving quadratic equations and follow up with an interview. The test questions were constructed based on the items in textbooks and past examination papers involving the factorisation method, the quadratic formula, and problems solving in quadratic equations. The test was administered to the students where students had to show knowledge of solving the quadratic equations in the test.

Researchers used semi-structured interviews as an instrument in this study to identify the causes of students' committing such errors from the perspective of the students themselves. Interview questions consist of structured questions and unstructured questions (Mahmud & Yunus, 2018). Respondents for this semi-structured interview will be selected based on the achievements of 30 students who have undergone the diagnostic test. After analysing the student's results in the diagnostic test, the researcher selects three students who consist of different levels of achievement, such as high level, moderate level, and low level in these topics. The interviews were carried out using the Newman Error Hierarchy Model (1977) which aimed to determine the types of errors committed by the students on this topic.

The researchers chose passive participation observation in this study because researcher will only observe and record student activity in solving quadratic equations rather than participate in student activity in solving quadratic equations. In determining the validity of this diagnostic test, the researchers used content validity. The content validity of an

instrument is concerned with the representativeness of the targeted construct and the degree to which an assessment instrument is relevant to the research (Rusticus, 2014). The instrument validator is two mathematics teachers who have had more than 15 years of experience.

**Data Analysis**

In this study, Miles, Huberman, and Saldana's Interactive Analysis models were utilized to conduct data analysis, which included data collection, data reduction, data presentation, and findings (Uin & Banjarmasin, 2018). According to Newman, the data would be detected and categorized into five sorts of errors: reading error, comprehension error, transformation mistake, process skills fault, and encoding error.

To gather data for this study, researchers performed qualitative content analysis. According to (Nik Azis, 2014), qualitative content analysis is a subjective, qualitative, and scientific way of evaluating the content of textual material through the classification process.

**Result**

This study discusses students' errors in solving quadratic equations. Errors were analysed based on students' errors in solving process and the results showed below. Table 1 shows frequency of students' errors, and each response of each item was grouped into one of the six categories accordingly.

Table 1 Frequency of students' error

| QUESTION | CORRECT ANSWER | TYPES OF ERROR | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | V |
| 1 | 22 (73.3%) | 0 (0.0%) | 5 (16.7%) | 3 (10.0%) | 0 (0.0%) | 0 (0.0%) |
| 2 | 24 (80.0%) | 0 (0.0%) | 3 (10.0%) | 3 (10.0%) | 0 (0.0%) | 0 (0.0%) |
| 3 | 25 (83.4%) | 0 (0.0%) | 4 (13.3%) | 1 (3.3%) | 0 (0.00%) | 0 (0.0%) |
| 4 | 18 (60.0%) | 0 (0.0%) | 4 (13.3%) | 6 (20.0%) | 2 (6.7%) | 0 (0.0%) |
| 5 | 19 (63.3%) | 0 (0.0%) | 3 (10.0%) | 5 (16.7%) | 3 (10.0%) | 0 (0.0%) |
| 6 | 24 (80.0%) | 0 (0.0%) | 2 (6.7%) | 2 (6.7%) | 2 (6.7%) | 0 (0.0%) |
| 7 | 13 (43.3%) | 0 (0.0%) | 5 (16.7%) | 6 (20.0%) | 6 (20.0%) | 0 (0.0%) |
| 8 | 16 (53.3%) | 0 (0.0%) | 4 (13.3%) | 5 (16.7%) | 4 (13.3%) | 1 (3.3%) |
| 9 | 17 (56.7%) | 0 (0.0%) | 2 (6.7%) | 7 (23.3%) | 4 (13.3%) | 0 (0.0%) |
| 10 | 18 (60.0%) | 0 (0.0%) | 1 (3.3%) | 6 (20.0%) | 2 (6.7%) | 3 (10.0%) |
| TOTAL | **196 (65.3%)** | **0 (0.0%)** | **33 (11.0%)** | **44 (14.7%)** | **23 (7.7%)** | **4 (1.3%)** |

Key:I=Reading, II=Comprehension, III=Transformation, IV=Process Skill, V=Encoding

Overall, the frequency of transformation and comprehension type errors was the highest and was followed by process skill errors. The table above shows 65.3% of the items in test were answered correctly by students. The highest error made by students in this topic is transformation error (14.7%) and follow by comprehension error (11.0%). Process skill error was 7.7% whereas encoding error (1.3%) was the least error made by students in solving quadratic equations. On the other hand, there is no reading error made by students.

**a) Reading Error**

The first error being identified was a reading error. Reading error is an error when students are wrong in reading important words in the question or students are wrong in reading information. However, in the aspect of reading error, there is no error made by the student.

**b) Comprehension Error**

A comprehension error is where the students able to read the question but failed to understand the questions and therefore unable to solve the questions. The students did not understand the meaning of 'six years ago' which then failed him to move the next level of problem solving. This error was made by the students because of lack of understanding of the

language and neglect the important information which resulted in the students not being able to solve the problem correctly.

Question 7

A girl is now three times young as her father. Six years ago, the product of their ages was 420. Find the present age both of them.

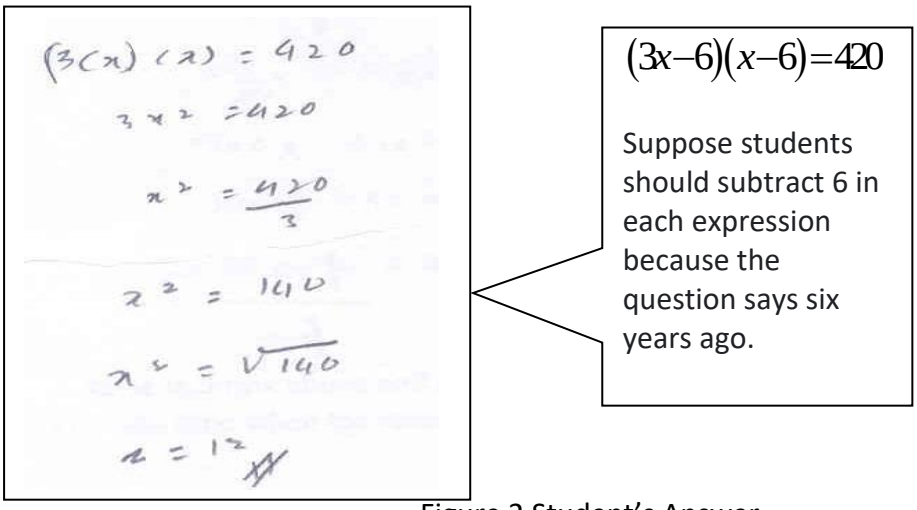



Figure 2 Student's Answer

The analysis showed that the student revealed comprehension error. The students failed to convert the words in the problem solving into quadratic equation, hence ended up with formulating wrong calculations. The following interview took place with Student 1.

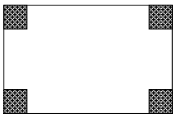
| | |
|---|---|
| Researcher | : Please read the question. |
| Student 1 | : (Read the question without any error). |
| Researcher | : Good. Now, can you tell me, what the question wants? |
| Student 1 | : Err, to find the present age both of them. |
| Researcher | : Ok. Let's look back at the question, what does 'six years ago, the product of their ages was 420' means? |
| Student 1 | : Hmm. |
| Researcher | : Alright. Let me show you the correct answer. (Researcher showed the answer to the student). Can you identify where is the mistake you did? |
| Student 1 | : I didn't minus six. |

The conversation with Student 1 shows that the student able to solve the problem but overlook the main content of the question. Therefore, he knows how to solve the questions but is caught up by writing a wrong algebraic expression.

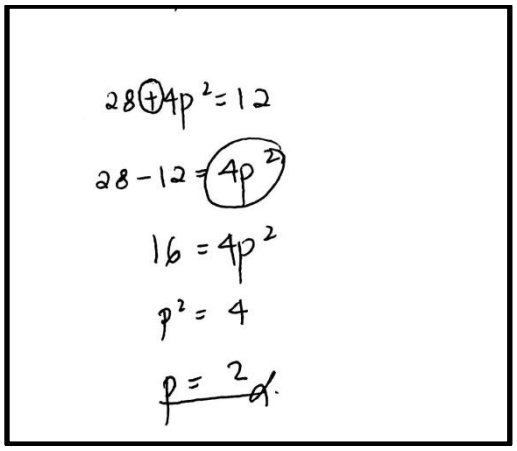
**c) Transformation Error**

The transformation error is an error when the student incorrectly transforms the problem into a mathematical model such as equation, image, graphic or table. In this study, the student able to write quadratic equation but fail to use the correct operation.

Question 6



The area of rectangular is 28 $cm^2$ and each shaded area is $p^2$ $cm^2$. If the shaded area is cut out from the cardboard and the remaining area of the cardboard is 12$cm^2$ find the value of p.




Student makes error while expand the expression

$$=(x+2)(3x-6)+(4x+5)(x+6)+(5x+4)(x)$$
$$=3x^2-12+4x^2+29x+30+5x^2+4x$$
$$=12x^2+33x+18$$

Figure 3 Student's Answer

This student revealed transformation error where he knows to form quadratic equation but mistaken use the wrong operation. Suppose he need to subtract $4p^2$ and then, he manifested technical error while rearranging the equation. Anyhow, this student knew how to solve the equation but then failed to perform correct working although the answer is correct. The following conversations took place with Student 3.

| | |
|---|---|
| Researcher | : Now, please read the question 6. |
| Student 3 | : (Read the question fluently). |
| Researcher | : Ok. Can you tell me what is the error you have done? |
| Student 3 | : I accidently put plus symbol. |
| Researcher | : May I know why you did such mistake? |
| Student 3 | : I'm in rush to complete the question so I overlooked the question. |

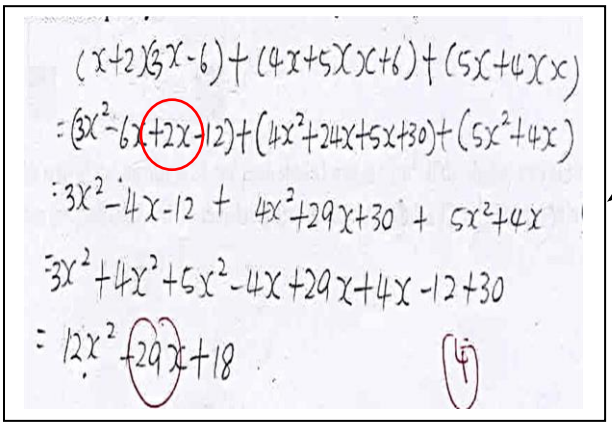
The conversation with Student 3 shows the student revealed an error in writing the correct sign. This student attempt to solve the quadratic equation but since he writes $+4x^2$ instead $-4x^2$, then this led to wrong steps next.

**d) Process Skill Error**

The process skill error occurred when there is arithmetic error, procedural error and incomplete solutions. In this study, students committed procedural error as student comprehended the question's content well but having problem when dealing with factorisation and expansion method.

Question 4

2 kg of fish is RM 6 cheaper than triple the price of 2 kg of chicken while price for 2 kg of crab is RM 6 more expensive than 2 kg of chicken. Assuming the price of 2 kg of chicken is RM x, find the total cost for (x+2) kg of fish, (4x+5) kg of crab and (5x+4) kg of chicken. Express your answer in the form of quadratic expression.




Arithmetic error

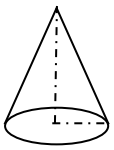
$$=(x+2)(3x-6)+(4x+5)(x+6)+(5x+4)(x)$$
$$=3x^2-12+4x^2+29x+30+5x^2+4x$$
$$=12x^2+33x+18$$

Figure 4 Student's Answer

The response showed that the student did an arithmetic error while expand the expression result ended up wrong answer. He did not realise about the error that he made since he continues the steps till the final answer. The following interview took place with Student 2.

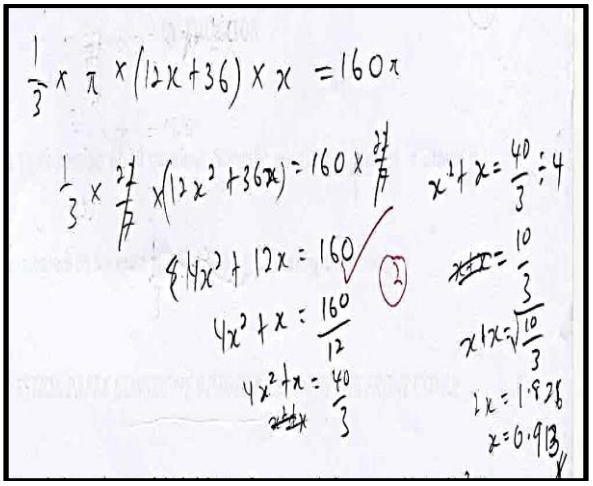
| | |
|---|---|
| Researcher | : Ok. Let see question 4. Did you understand the question? |
| Student 2 | : Yes, teacher. |
| Researcher | : Ok. Now, can you tell me what is the error you have done? |
| Student 2 | : I wrongly calculate. I multiply 2 and x. |

Question 9



The diagram above shows a cone with height x cm and the side of the cone is (x+6) cm. Express the radius of the base cone in x value. Then, find the value of x if the volume of cone is 160 π $cm^3$.

(Volume $\frac{1}{3}\pi r^2 h$)



Procedural error

$4x^2+12x=160$

$4x^2+12x-160=0$

$4(x+8)(x-5)=0$

$x=-8 \quad x=5$

Figure 5 Student's Answer

The student commit in this error due to the mistake in writing 160 on the right-hand side of the equation instead of zero. Then, she did not rearrange the equation in general form of equation before performing factorisation and this led her to make process skill error. The following conversations took place with Student 3.

| | |
|---|---|
| Researcher | : Then, see question 9. Can you show me the working steps that you have used to solve it? |
| Student 3 | : (Write the working on paper). |
| Researcher | : Ok. Can you tell me what is the error you have done? |
| Student 3 | : I'm not sure teacher. |
| Researcher | : Let me show the correct working. |
| Student 3 | : (Looking at the working). |
| Researcher | : Can you identify the error that you made in this question? |
| Student 3 | : Yes. I didn't do factorisation. |

Question 8

Ali and his friends chartered a boat for RM 120 for a trip to an island at the last moment, one of the them opts out, resulting in each of the remaining people have to pay RM 10 more. If the cost of chartering the boat shared equally among them, find how many people are there at the beginning?

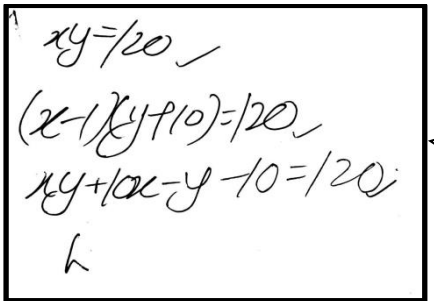



Figure 6 Student's Answer

Incomplete solution

$xy = 120$ $(x-1)(y+10) = 120$

$x = \frac{120}{y}$ $xy + 10x - y - 10 = 120$

$120 + 10\left(\frac{120}{y}\right) - y - 10 = 120$

$\frac{1200}{y} - y - 10 = 0$

$1200 - y^2 - 10y = 0$
$y^2 + 10y - 1200 = 0$
$(y-30)(y+40) = 0$
y = 30 y = - 40 (rejected)

The student's response showed that he stuck in the middle as he faces difficulties in completing the question. The following interview except took place with Student 1. He failed to realise that he needs to factorise the equation to get final answer.

| | |
|---|---|
| Researcher | : Why you did not finish question 8? |
| Student 1 | : I don't know how to do. |

The conversation with students shows the student revealed an error in arithmetic, factorisation and solving the equation because they did not master the concept of solving quadratic equation well. Therefore, the students commit in process skills error which finally lead to wrong solution.

**e) Encoding Error**

Based on the analysis, the student able to read, transform, comprehend and make procedural solution. However, the answer did not comply with the question's needs in minutes for the time taken. Therefore, this error leads the student to committed in encoding error.

Question 10

A stone is thrown above and the height, t m from ground after p second is $t = 16p^2 - 88p$.
Find the time, in minutes, when the stone at the height of 73 m from ground.

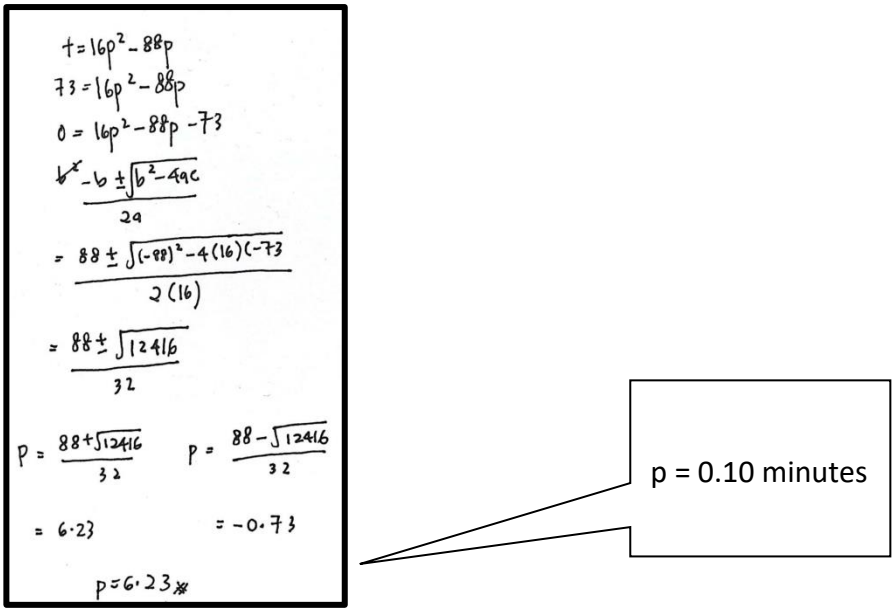


Figure 5 Student's Answer

The student's response showed that he did an encoding error where the final answer for the time taken should be in minutes while the student gives answer in seconds. The following interview except took place with Student 2.

| | |
|---|---|
| Researcher | : Let see question 10. Did you understand the question? |
| Student 2 | : Yes. |
| Researcher | : Can u read the question. |
| Student 2 | : (Read the question without any error) |
| Researcher | : What the questions wants? |
| Student 2 | : Find time taken, in minutes, when the stone at the height of 73 m from ground. |
| Researcher | : Did you do the error you made in this question? |

The conversation with Student 2 shows the student able to solve the problem but overlook the requirement of the question which cause him to make encoding error.

**Discussion**

Based on the results, it appears that the majority of the students managed to answer the first three questions correctly. More than 70% of the students scored correctly on items 1, 2 and 3 because these three questions were not complex and tricky for the students, as they were at an understanding level. It is not a surprise that the majority of the students were able to answer them without any complex problems.

On the other hand, questions 3,4,5,6 and 7 were placed at the moderate level for the students because the questions were intended to enhance students' critical thinking, which resulted in more students making transformation errors. Finally, questions 8, 9 and 10 were problems that required students to think critically and relate all the methods that they have learned to solve them. It was found that less than 60% of students were able to answer.

The most frequent errors committed by students in using factorization include transformation errors, comprehension errors, and process skill errors. Students have problems understanding the questions and often misunderstand the needs of the questions.

This weakness is probably due to the lack of emphasis by the teacher in the teaching and learning process about how to transform the problem solving into a mathematics equation (Mahmud et al., 2021). This supports Singh et al. (2010) contention that when tackling mathematical problems in English, students had more difficulty with content knowledge than with language difficulties.

Besides that, the transformation error occurred during the expansion of algebraic expression. Students make errors in positive and negative signs involved in computation. The finding of the study supports the research of Tendere (2020) that most students have problems simplifying algebraic expressions and factorization, as well as performing algebraic operations. Based on interview analysis, it shows that the main reason students make errors in solving quadratic equations is a lack of understanding of the basic concepts and the learning styles. This is agreed upon by Gözde & Kabar (2018), who states that students lack prerequisite knowledges and they face difficulty in factorization.

## Conclusion

The understanding of the concept in topic should be given priority in determining one's success and no longer to academic achievement alone. This study found the highest occurrence of transformation error, followed by comprehension error, process skill error, encoding error and none in reading error. Therefore, teacher and student must understand the importance to eliminate these errors in quadratic equation. If these errors not tackle at the early stage, it will give huge impact to the students' learning mathematics in the future. This study could give information to other researcher, teacher and academic institution on types of mathematical error by looking into the method and findings section covered in this study. In a nutshell, the role of teachers is important in enhancing the potential of students. An educator must be creative in choosing the manner of delivery and the appropriate method so that the lesson can be delivered effectively based on objectives and students are able to understand the concepts. In addition, the teacher should emphasis more on word problem and drill the students with effective solving strategies.

## References

Abdullah, A. H., Abidin, N. L. Z., & Ali, M. (2015). Analysis of Students' errors in Solving Higher Order Thinking Skills (HOTS) Problems for the Topic of Fraction. *Asian Social Science*, *11*(21), 133–142. https://doi.org/10.5539/ass.v11n21p133

Ah Huat, T. (2015). Kaedah Penfaktoran Ajaib Ungkapan Kuadratik (P.A.U.K). *Jurnal Penyelidikan Kent*, *14*.

Rahman, A., & Author, C. (n.d.). *Analysis of Student's Answer Error in Learning Mathematics Using Newman Analysis*. *8*(6), 77–82. https://doi.org/10.9790/7388-0806037782

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education: Vol. Sixth Edition*.

Didis, M. G., & Erbas, A. K. (2015). Performance and Difficulties of Students in Formulating and Solving Quadratic Equations with One Unknown. *Kuram ve Uygulamada Egitim Bilimleri*, *15*(4), 1137–1150. https://doi.org/10.12738/estp.2015.4.2743

Dj Pomalato, S. W., Ili, L., Ningsi, B. A., Fadhilaturrahmi, Hasibuan, A. T., & Primayana, K. H. (2020). Student error analysis in solving mathematical problems. *Universal Journal of Educational Research*, *8*(11), 5183–5187. https://doi.org/10.13189/ujer.2020.081118

Fadhilah Zamzam, K., & Alfiana Patricia, F. (2018). *Error Analysis of Newman to Solve the Geometry Problem in Terms of Cognitive Style*.

Faradilla, T., Rahman, A., Ardillah, N., Abd, B., & Effendy, H. (2019). *Exploring Students' Error in Quadratic Word-Problem Using Newman Procedure*.

Gözde, M., & Kabar, D. (2018). Secondary School Students' Conception of Quadratic Equations with One Unknown. In *INTERNATIONAL JOURNAL FOR MATHEMATICS TEACHING AND LEARNING* (Vol. 1).

Hassan, S. R., Rosli, R., & Zakaria, E. (2016). The Use of i-Think Map and Questioning to Promote Higher-Order Thinking Skills in Mathematics. Creative Education, 07(07), 1069–1078.

Langoban, M., & Langoban, M. A. (n.d.). *What Makes Mathematics Difficult as a Subject for most Students in Higher Education?* https://www.researchgate.net/publication/342888714

Mahmud, M. S., Rosli, R., Maat, S. M., & Mohd, N. F. (2021). Teacher Questioning in Mathematics Teaching : Feedback that Stimulates Productive Teaching. 12(5), 126–136.

Mahmud, M. S., & Yunus, A. S. M. (2018). The Practice Of Giving Feedback Of Primary School Mathematics Teachers In Oral Questioning Activities. Journal of Advanced Research in Dynamical and Control Systems, 10(12), 1336–1343.

Mahmud, M. S., Yunus, A. S. M., Ayub, A. F. M., & Sulaiman, T. (2019). Impact of school location and professional qualification on level of giving feedback among primary school mathematics teachers in oral questioning process. Religación. Revista de Ciencias Sociales y Humanidades, 4(18), 467–473.

Mahmud, M. S., Zainal, M. S., Rosli, R., & Maat, S. M. (2020). Dyscalculia : What We Must Know about Students ' Learning Disability in Mathematics ? Universal Journal of Educational Research, 8(12B), 8214–8222.

Makgakga, S. (2014). *Errors And Misconceptions in Solving Quadratic Equations by Completing A Square*. http://www.amesa.org.za/AMESA2014/Proceedings/papers/Short%20Paper/4.%20Sello%20Makgakga%20-AMESAPAPER2014final.pdf

Mutambara, L. H. N., Tendere, J., & Chagwiza, C. J. (2020). Exploring The Conceptual Understanding of The Quadratic Function Concept in Teachers' Colleges In Zimbabwe. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(2), 1–17. https://doi.org/10.29333/ejmste/112617

Azis, N. P. (2014). *Penghasilan Disertasi Berkualiti dalam Pendidikan Matematik.* Penerbit Universiti Malaya.

Rohmah, M., & Sutiarso, S. (2018). Analysis Problem Solving in Mathematical using Theory Newman. *Eurasia Journal of Mathematics, Science and Technology Education*, *14*(2), 671–681. https://doi.org/10.12973/ejmste/80630

Rosli, R. A., & Rasdi, N. (2015). Analisis Kesilapan Pemfaktoran Ungkapan Kuadratik dalam Kalangan Pelajar Semester Satu di Politeknik Sultan Idris Shah. *1st National Conference on Business & Innovation*, 599–609.

Rr Chusnul, C., Mardiyana, & Retno, D. S. (2017). Errors analysis of problem solving using the Newman stage after applying cooperative learning of TTW type. *AIP Conference Proceedings*, *1913*. https://doi.org/10.1063/1.5016662

Rusticus, S. (2014). Content Validity. In A. C. Michalos (Ed.), *Encyclopedia of Quality of Life and Well-Being Research* (pp. 1261–1262). Springer Netherlands. https://doi.org/10.1007/978-94-007-0753-5_553

Santoso, D. A., Farid, A., & Ulum, B. (2017). Error Analysis of Students Working about Word Problem of Linear Program with NEA Procedure. *Journal of Physics: Conference Series*, *855*(1). https://doi.org/10.1088/1742-6596/855/1/012043

Shelley, M., & Kiray, S. A. (2019). *Erhmst2019_24-12-2019*. Published by ISRES Publishing, International Society for Research in Education and Science (ISRES).

Singh, P., Rahman, A. A., & Hoon, T. S. (2010). The Newman procedure for Analyzing Primary Four Pupils errors on written mathematical tasks: A Malaysian perspective. *Procedia - Social and Behavioral Sciences*, *8*, 264–271. https://doi.org/10.1016/j.sbspro.2010.12.036

Susac, A., Bubic, A., Vrbanc, A., & Planinic, M. (2014). Development of abstract mathematical reasoning: The case of algebra. *Frontiers in Human Neuroscience*, *8*(SEP). https://doi.org/10.3389/fnhum.2014.00679

Tendere, J. (2020). An Analysis of Errors and Misconceptions in the Study of Quadratic Equations. *European Journal of Mathematics and Science Education*, *1*(2), 81–90. https://doi.org/10.12973/ejmse.1.2.81

Uin, A. R., & Banjarmasin, A. (2018). *Analisis Data Kualitatif* (Vol. 17, Issue 33).

Wahab, R. A., Hidayat, R., & Zakaria, E. (2014). *Analisis Kesilapan dalam Pembelajaran Pengamiran Create Engineering Mathematics Teaching Project View Project*. https://www.researchgate.net/publication/278848212

Yadav, S. (2019). Role of Mathematics in the Development of Society. *International Journal of Research and Analytical Reviews*. www.ijrar.org

Zakaria, E. (2010). Analysis of Students' Error in Learning of Quadratic Equations. In *International Education Studies* (Vol. 3, Issue 3). www.ccsenet.org/ies