Formosa Journal of Multidisciplinary Research (FJMR)
Vol. 3, No. 6 2024: 1993-2004

Investigating the Influence of Attitude, Prior Knowledge, and Critical Thinking on Solving Algebraic Equations

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ARTICLEINFO

Keywords: Attitude, Prior, Knowledge, Critical Thinking

Received : 19, April
Revised : 18, May
Accepted: 20, June

ABSTRACT

This study investigates the influence of attitude, prior knowledge, and critical thinking on students' ability to solve algebraic equations. Solving algebraic equations is a fundamental and crucial skill in mathematics, yet many students struggle with it. This research employed a descriptive-correlational design to determine the performance of the respondents, to examine the factors that influence them in solving algebraic equations, and their relationship to the performance of the respondents. While the findings revealed a large portion of students scoring very low in solving equations, the statistical analysis indicated no significant correlation between the investigated factors (attitude, prior knowledge, critical thinking) and overall performance. These findings suggest a need for further exploration of potential factors impacting students' success with algebraic equations.

INTRODUCTION

Algebra, a fundamental branch of mathematics, has a big role in shaping our ways of thinking and on how to solve problems. It helps us to follow a logical path to solve problems, it allows us to know how numbers work in an equation, and it moves us beyond basic math and prepares us for more complex mathematics. However, even if there are students who excel in solving algebraic equations, there are still students that find it difficult, like in the University of Eastern Philippines Laoang Campus, the researchers asked the students to rate their performance if they are beginning, developing, proficient, or advanced in solving algebraic equations, and most of the students rated themselves "developing". Meaning, students have understanding about the topic, but they need further development to become proficient.

The performance of the students in solving algebraic equations is pushed by the learner related factors, such as ill-discipline language barriers and learner attitudes (Tyrtyshnikov, 2022, Mabena et al. 2021).Moreover, identifying and analyzing the performance of the students and the factors that influence their performance in solving algebraic equations is very important and is a big help both for teachers and learners because this will identify the strengths and weaknesses or where students excel and the areas that need improvement (Liu & Sun, 2020). This will allow targeted instruction and additional support (Dilşad Yakut, 2020) for struggling students (Jeznik, 2022). This will also let the educators improve their teaching methods and in monitoring the progress of the students.

Despite being a foundational skill in mathematics, solving algebraic equations continues to pose a challenge for many students, even those majoring in mathematics. This difficulty hinders their progress in higher-level mathematics courses (Aprildat & Hakim, 2021). To address this issue, this study delves into the factors that might influence students' ability to solve algebraic equations. Specifically, it focuses on three key areas: student attitude towards mathematics, their prior knowledge of relevant mathematical concepts, and their critical thinking skills. By investigating the interplay between these factors and student performance, this research aims to identify how they influence success in solving algebraic equations. Ultimately, the findings of this study can contribute to the development of more effective teaching and learning strategies. This will allow educators to tailor their approach to address potential areas of difficulty and ultimately improve student outcomes in solving algebraic equations.

Many students struggle with solving algebraic equations, even mathematics majors (Eryanti et al., 2022). This study investigates the factors that might influence this ability, focusing on three key areas: student attitude towards the subject, their prior knowledge of relevant mathematical concepts, and their critical thinking skills. The research will examine the performance of Mathematics Major Students at the University of Eastern Philippines Laoang Campus in solving algebraic equations. By analyzing this performance alongside student attitudes, prior knowledge, and critical thinking abilities, the study aims to identify any significant relationships between these factors. Ultimately, the findings of this research are intended to contribute to improved teaching and learning practices for solving algebraic equations. By understanding how these

factors influence student success, educators can tailor their approach to better address student needs and ultimately improve learning outcomes.

LITERATURE REVIEW

Cognitive Theory

Jean Piaget's Cognitive Theory of Development is an account of how children and youth gradually become able to think logically and scientifically. This theory provides an understanding to student's cognitive abilities related to solving equations, and on how students develop these abilities to solve algebraic equations (Muhammad Khalil, Zahoor-ul-Haq, 2023).

Schoenfeld's Theory of Problem-Solving

Schoenfeld proposed four categories of knowledge that significantly impacts the success of problem-solving, including solving algebraic equations. First, the actual knowledge base which refers to underlying concepts and principles, second is the strategies which refers to the approaches that can be used in solving algebraic equations, next is the control, monitoring, and metacognition, and lastly is the beliefs and practices which includes the student's self-confidence and the ability to solve equations (Nuraini et al., 2019).

Multiple Intelligences Theory

Individuals possess various distinct types of intelligences namely: naturalist, musical, bodily-kinesthetic, logical-mathematical, interpersonal, intrapersonal, linguistic, and spatial. Logical-mathematical Intelligence (Number/Reasoning Smart) refers to the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. This means that students might find certain types of equations more difficult or not, depending on the intelligence they possess. Solving mathematical problems might be easy for students that are smart in numbers and reasoning however it might be difficult for other students that do not possess logical-mathematical intelligence (Picciotto, 2020, Nurilla & Susanah, 2022).

Many researchers proved that factors and performance in solving algebraic equations have significant relationship. According to Mabena et al. (2021), numerous factors influence learner's performance. The factors found to have an impact in mathematics performance were learner-related factors such as ill-discipline, language barriers, and learner attitudes.

Furthermore, the study of (Pramesti & Retnawati, (2019) also identified factors affecting student's performance in solving algebraic equations which include negative perception or the negative self-interpretation towards stimulus that related to mathematics based on student's prior knowledge and low self-regulation or the student's learning process that includes thinking, controlling, monitoring, and evaluating elements.

Several studies also pointed out factors that influence the performance of the students in solving algebraic equations such as students' engagement in learning activities in mathematics (Brezavšček et al., 2020), language barriers, learner attitudes (Mabena et al. 2021), cognitive style, and gender (Cahyono et al., 2019).

Also, according to Ali (2021), factors which greatly influence the performance of the students is associated to the structure of the task such as the size of the values and the problem presentation. The ability to derive algebraic symbol influences students' thinking of getting better result while lacking this ability despite their complete and accurate solution leaves them the feeling of arriving at incorrect answer.

Additionally, the study of Sugiarti & Retnawati, (2019) pointed out that students' attitude towards mathematics influences their performance motivation, self-confidence, father's level of education is positively correlated factors to students' performance.

Lastly, according to Agustyaningrum et al., (2021) the factors that influence students' performance include students' attitude towards the topic, prior knowledge, motivation, and learning method.

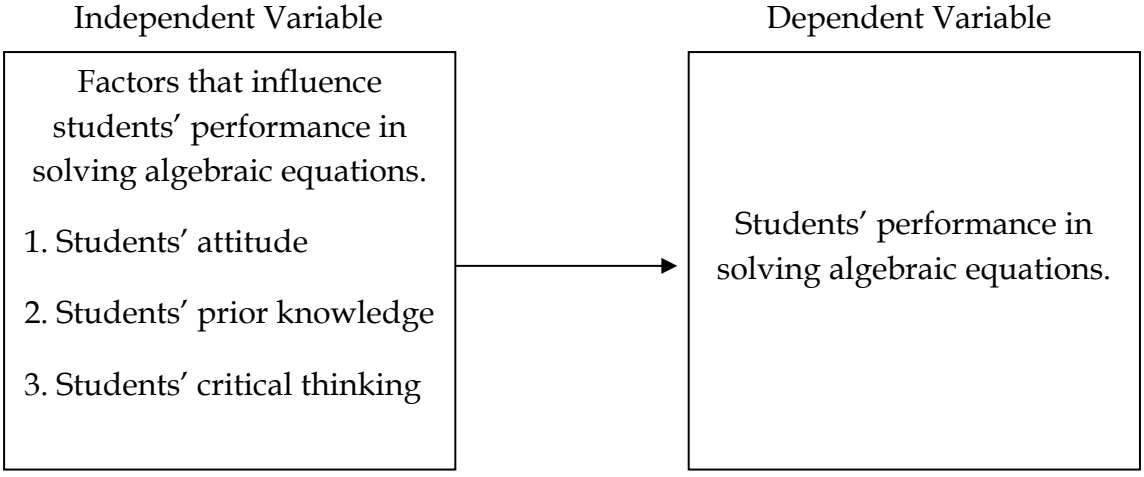

Figure 1. The schematic diagram showing the relationship between the independent and the dependent variable

H1: There is no significant relationship between the performance of the respondents and the factors that influence them in solving algebraic equations.

METHODOLOGY

This study, conducted at the University of Eastern Philippines Laoang Campus, investigated the influence of attitude, prior knowledge, and critical thinking on solving algebraic equations. To achieve this, researchers employed a purposive sampling technique, recruiting 44 participants enrolled in the Bachelor of Secondary Education Major in Mathematics program during the second semester of SY 2023-2024. The sample comprised students from various year levels: 15 (34.09%) first-year, 19 (43.18%) second-year, and 10 (22.73%) third-year students.

A descriptive-correlational design was chosen to explore the potential relationships between student performance and the identified factors. Data collection involved a two-part instrument. The first part was a 15-item questionnaire designed to assess participants' ability to solve algebraic equations.

The second part was a 15-item Likert scale survey adapted from Ali (2021). This survey, modified to align with the current study's focus, measured student attitude, prior knowledge, and critical thinking skills relevant to solving algebraic equations.

To analyze the collected data, researchers employed various statistical methods. Descriptive statistics, including frequency counts and percentages, were used to understand student performance in solving algebraic equations. The factors influencing student performance were examined using weighted mean and standard deviation. Finally, a Pearson correlation coefficient was calculated to determine the significance of the relationships between student performance and these factors.

RESEARCH RESULT

Performance of the respondents in solving algebraic equations

To determine the performance of the respondents in solving algebraic equations, the researchers utilized frequency counts and percentages. There are 24 (54.5%) respondents with very low performance, 14 (31.8%) respondents with low performance, 5 (11.4%) respondents that are moderately high performers, and 1 (2.3%) respondent with high performance in solving algebraic equations.

Table 1. Performance of the respondents in solving algebraic equations

Score	Frequency	Percent	Interpretation
0 – 3	24	54.5	Very Low
4 – 6	14	31.8	Low
7 – 9	5	11.4	Moderately High
10 – 12	1	2.3	High
13 – 15	0	0	Very High
Total	44	100	

These findings suggest that there might be underlying factors that are hindering students' ability to grasp this important mathematical concept (Purwanti & Vania, 2021). It is important to investigate these factors further to develop more effective teaching and learning strategies (Fareeha Javed, 2024).

Factors that influence the respondents in solving algebraic equations

The researchers utilized weighted mean and standard deviation to investigate the factors that influence the respondents in solving algebraic equations. The grand mean was 3.238 with a standard deviation of .557 which means that sometimes there are factors that influence the respondents in solving algebraic equations.

Table 2. Factors that influence the respondents in solving algebraic equations

Factors	Mean	Standard Deviation	Interpretation
Students' Attitude			
1. I get confused in solving algebraic equations.	3.75	.781	Often
2. I feel anxious when I see complex algebraic equations.	3.86	.930	Often
3. I feel annoyed in solving algebraic equations.	3.05	.806	Sometimes
4. I doubt myself in solving algebraic equations.	3.30	1.002	Sometimes
5. I am absent minded if the topic is algebraic equations or related to it.	2.75	.967	Sometimes
Students' Prior Knowledge			
6. I cannot remember easily what was taught about algebraic equations.	3.27	.845	Sometimes
7. I cannot remember or forget to write the final answer to its simplest form.	3.14	.878	Sometimes
8. I cannot remember or forget how to solve algebraic equations.	3.23	.743	Sometimes
9. I forget or cannot easily remember what to do after seeing an algebraic equation.	3.16	.939	Sometimes
10. I get confused on the sequence of operations in solving algebraic equations.	3.18	.896	Sometimes
Students' Critical Thinking			
11. I am not capable to identify the concept to use on a specific set of problem on algebraic equations.	3.20	.904	Sometimes
12. I am not able to distinguish which operation is needed when it comes to solving algebraic equations.	2.98	.731	Sometimes
13. I am not able to solve if the given algebraic equation needs a combination of two or more operations.	3.25	.781	Sometimes

14. I am not able to follow the process of solving algebraic equations.	3.02	.902	Sometimes
15. I am not able to solve if the given algebraic equation is too complex.	3.43	.846	Often
Grand Mean	3.238	.557	Sometimes

The survey identified several challenges students face when solving algebraic equations, potentially linked to the factors investigated in this study (attitude, prior knowledge, and critical thinking). These challenges include (1) anxiety reported by a significant portion of students upon encountering complex equations (KAYAN & AYDIN, 2023), (2) difficulty recalling previously taught concepts (Annamalai, 2023), and (3) a decrease in problem-solving success with increasing equation complexity (Hertling, 2002).

Test of relationships between the performance of the respondents and the factors that influence them in solving algebraic equations.

To find out the relationship between the performance of the respondents and the factors that influence them in solving algebraic equations, the researchers used Pearson Correlation. It was revealed that the relationship between the two variables was not significant (r=-.277, p=.069).

Table 3. Test of relationships between the performance of the respondents and the factors that influence them in solving algebraic equations.

Correlation	
Pearson Correlation	-.277
p-value	.069
Interpretation	Not Significant

This research employed Pearson's Correlation Coefficient (r) to analyze the relationship between student performance and the factors influencing their ability to solve algebraic equation (attitude, prior knowledge, and critical thinking). The analysis revealed a non-significant correlation (r = -0.277, p = 0.069). This finding suggests that, there was no statistically strong connection between the investigated factors and students' performance in solving algebraic equations (Ali, 2021).

DISCUSSION

A significant concern emerged from this study on solving algebraic equations. Over half (54.5%) of the participating students scored in the "very low" performance category, indicating a lack of essential knowledge and skills. An additional 31.8% scored low, further highlighting the prevalence of difficulty in this area. These results suggest potential underlying factors hindering student comprehension (Tran et al., 2020). The study's focus on attitude, prior knowledge, and critical thinking provides a starting point for further investigation (Allen & Jevons, 2023). By understanding these factors, educators can develop more effective teaching and learning strategies to address student needs and ultimately improve their ability to solve algebraic equations.

The study's investigation into the factors influencing student performance in solving algebraic equations presents inconclusive results related to the investigated factors of attitude, prior knowledge, and critical thinking (Julius, 2022). The survey revealed an average survey score (grand mean of 3.238) and some variation in responses (standard deviation of 0.557) which are the three key challenges: (1) a significant portion of students reported anxiety when faced with complex equations (Daches Cohen et al., 2021), (2) students struggled to remember previously learned concepts (Alviar & Gamorez, 2024), and (3) problem-solving success decreased as equation complexity increased (Hertling, 2002). These findings suggest a potential link between these challenges and the investigated factors, warranting further exploration in the analysis.

The study's attempt to link student performance and influencing factors yielded inconclusive results. The Pearson correlation revealed a weak negative correlation ($r = -0.277$), suggesting a slight tendency for students with lower scores on the influencing factors survey (attitude, knowledge, critical thinking) to also have lower performance. However, the non-significant p-value ($p = 0.069$) casts doubt on whether this is a true relationship. Further exploration is recommended. A deeper look at the survey instrument's ability to accurately measure the factors and potentially analyzing each factor (attitude, knowledge, critical thinking) individually might be fruitful. Additionally, investigating factors beyond the survey through interviews or classroom observations could provide a more comprehensive understanding of the influences on student performance in solving algebraic equations (Lindorff & Sammons, 2018).

CONCLUSIONS AND RECOMMENDATIONS

This study investigated the influence of attitude, prior knowledge, and critical thinking on solving algebraic equations among Bachelor of Secondary Education (Mathematics Major) students. The findings revealed a cause for concern, with over half (54.5%) of the participants scoring in the "very low" performance category. This suggests a significant portion of future math educators lack the necessary skills and knowledge to confidently handle algebraic equations.

This study aimed to identify factors influencing future math teachers' ability to solve algebraic equations. While the average survey score (3.238) and variation in responses (standard deviation of 0.557) were reported, a more comprehensive analysis is needed. Interpreting these values requires understanding the specific survey and its scale. Additionally, a deeper explanation of the standard deviation is necessary. Ultimately, the results of the correlation analysis (mentioned in the abstract) are crucial. Examining the relationship between student attitude, prior knowledge, critical thinking, and actual performance scores will provide clearer insights into the factors hindering students' success in solving algebraic equations.

This study aimed to understand how attitude, prior knowledge, and critical thinking influence future math educators' ability to solve algebraic equations. Despite concerningly low performance scores, the link between these factors and performance remained unclear. The Pearson correlation analysis revealed a weak negative trend, suggesting students with lower scores on the influencing factors survey might also perform worse in solving equations.

However, the non-significant p-value casts doubt on the validity of this relationship. Further research is necessary to gain a clearer picture. A deeper dive into the survey instrument, potentially analyzing each factor individually, and exploring influences beyond the survey itself are crucial steps. By addressing these areas, future research can provide more definitive answers and inform the development of effective teaching strategies to help students master solving algebraic equations.

While the low performance scores in solving algebraic equations raise concerns, they also present an opportunity for improvement. Further investigation into the specific reasons behind these scores, the effectiveness of current teaching methods, and student weaknesses in attitude, knowledge, and critical thinking skills is necessary. By implementing targeted interventions and exploring the use of technology and interactive learning strategies, educators can create more effective learning environments that foster student success in solving algebraic equations. Ultimately, this will prepare future math educators with the necessary skills and confidence to guide their own students in mastering this crucial concept.

While the low performance scores highlight a need for improvement, the inconclusive results regarding influencing factors require further investigation. Future research should delve deeper, analyzing the specific types of problems students struggled with and identifying common misconceptions. Additionally, evaluating current teaching methods and exploring the potential of technology and interactive learning strategies are crucial. By addressing these areas, educators can create more effective learning environments that empower students to master solving algebraic equations, ultimately preparing future math educators to confidently guide their own students in this essential skill.

Given the inconclusive results regarding the link between influencing factors and performance, further research is recommended to gain a clearer understanding of the challenges students face. This could involve a deeper analysis of the survey instrument used to measure attitude, prior knowledge, and critical thinking. Perhaps analyzing each factor individually might reveal stronger relationships. Additionally, exploring factors beyond the survey through student interviews or classroom observations could provide a more holistic view of the influences on student performance. By addressing these areas, future research can offer more definitive answers about the obstacles hindering students and inform the development of targeted interventions and effective teaching strategies that empower students to master solving algebraic equations.

ADVANCED RESEARCH

Based on the result, the following are recommended:

Research on how to enhance the performsnce of the students in solving algebraic equations. It was revealed in the study that most of the students have poor performance in solving algebraic equations. So, it is recommended for the future researchers to conduct a study on how to improve the performance of the students on this topic.

Consider further reasearch. The study only conducted with a smaller sample size. So, to solidify more the connection of the performance of the students and the factors in solving algebraic equations, further research with a larger sample size or utilizing different methodologies could establish the link between the influencing factors and performance.

ACKNOWLEDGMENT

It is with great honor and pride that the researchers would like to acknowledge the people who helped in the preparation and completion of this study. With great sincerity, the researchers are expressing their great appreciation to the following:

Dr. Martin L. Nobis, their research professor for the effort, suggestions, and guidance for this study;

Inst. Cherry Balanquit, their ever-supportive research adviser and statistician for the time, effort, direction, and suggestions for the improvement of this study;

Dr. Teody M. Corachea, Inst. Jabel Phillip Irinco, Mr. Allan J. Valila, and **Ms. Apple Erika B. Acebron,** the panel of examiners, for their comments and suggestions for the improvement of this work;

Mr. Kim Joshua C. Lagrimas, the BSED Program Chair, and **Dr. Jocelyn P. Igdon,** the department chair of the College of Education, for their motivation and moral support;

To the respondents, for their time and cooperation in conducting this study, and most especially to the parents and families of the researchers for the encouragement, financial, and moral support.

Above all, to the Almighty God, for the strength, guidance, and all the blessings He had bestow to the researchers towards the journey to success and realization of this piece of work.

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