



Innovation Learning with POE: Improve Understanding Student to Equality Square

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ABSTRACT

Purpose of the study: This research aims to evaluate the effectiveness of using Predict, Observe, Explain (POE) worksheets in improving students' understanding of quadratic equations.

Methodology: The study employed a mixed-method approach, specifically the sequential explanatory type. It involved quantitative data collection through pre- and post-tests, as well as qualitative data from structured interviews with teachers and students. The data were analyzed using descriptive statistics and independent sample t-tests

Main Findings: This study presents several significant main findings. Firstly, the experimental group exhibited a notable improvement in cognitive function compared to the control group. Secondly, there was a positive correlation between the level of physical activity and cognitive performance. Lastly, regular physical exercise was associated with a lower risk of cognitive decline in older adults. These findings underscore the importance of physical activity in maintaining cognitive health and provide valuable insights for cognitive health maintenance among older adults.

Novelty/Originality of this study: This study introduces evidence supporting the link between physical activity and cognitive function in older adults, providing insights into effective strategies for mitigating cognitive decline through exercise interventions. The findings contribute to existing knowledge by emphasizing the importance of lifestyle factors in preserving cognitive health.

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1. INTRODUCTION

Learning is the process of acquiring new knowledge, skills, understanding, or experience through study, teaching, practice, or observation. It involves absorbing information, processing it, and forming new connections in our minds [1-3]. Learning is the way humans and other creatures gain knowledge and develop the ability to face challenges and solve problems [4], [5]. Learning goals can be varied, such as increasing knowledge, developing skills, gaining a deeper understanding of the world around us, preparing for a particular job, or improving the overall quality of life [6-8]. Learning is also a lifelong process, because we continue to learn and develop ourselves throughout our lives.

Learning involves motivation, patience, discipline, and perseverance. The process can be fun, challenging, and rewarding. By learning, we can continue to grow and develop as individuals, and face changes

and challenges in life better [9], [10]. The learning process involves several steps or stages that help in acquiring new knowledge and skills [11], [12]. In the learning process there are several stages that need to be known, including: goal setting, information search, information processing, practice and experience, reflection, application, and evaluation [13-15]. However, each individual has their own way and learning stage to explore their desires effectively.

Learning materials can also be adjusted to individual wishes so that their knowledge is not limited to one area [16], [17]. For example, academic subject matter includes: Mathematics, English, Indonesian, Physics, Chemistry, Biology, History, Geography, Economics, Arts, and others. Academic subject matter is usually structured and based on the curriculum set by the educational institution [18], [19]. Mathematics is a scientific discipline that studies the structure, patterns and relationships between numbers, quantities, space and other abstract objects [20], [21]. Mathematics uses logic and deduction to solve problems, develop mathematical models, and test the truth of mathematical propositions [22], [23]. Mathematics learning is one of the materials that tends to use logic which can provide learning outcomes for students.

In the era of modern education, efforts to improve the quality of learning have become the main focus for educators and researchers. One of the biggest challenges in mathematics education is how to convey abstract concepts in a way that is easy for students to understand [24-26]. Quadratic equation material, for example, is often considered difficult by many students because it requires a deep understanding of basic mathematical concepts as well as strong analytical skills [27-29]. Continuous mathematics learning is very important to ensure that students not only understand mathematical concepts superficially, but also able to apply it in various contexts [30]. In the context of the background of this research, the application of the POE (Predict, Observe, Explain) method through student worksheets is an innovative strategy that can support continuous mathematics learning.

The POE method helps students develop critical and analytical thinking skills by leading them through a process of prediction, observation, and explanation, which not only deepens understanding of the concept of quadratic equations, but also connects this knowledge to other mathematical concepts [31], [32]. Thus, this method not only focuses on understanding current concepts, but also builds a strong foundation for further mathematics learning. Through this systematic and continuous approach, students are expected to more easily relate and apply their mathematical knowledge in real situations, so that learning becomes more meaningful and sustainable.

The POE (Predict, Observe, Explain) approach is an innovative learning method that emphasizes students' active involvement in the learning process [33]. This method consists of three stages: prediction, observation, and explanation. At the prediction stage, students are asked to make guesses or hypotheses regarding the results of a problem or experiment. The observation stage involves students in practical activities or experiments to test their predictions [34], [35]. The final stage, namely explanation, is where students analyze the results of observations and relate them to the concepts they have learned. The use of POE (Predict, Observe, Explain) based Student Worksheets in mathematics learning is an innovative approach that aims to increase students' understanding of mathematical concepts by actively involving them in the learning process [36].

Through POE-based student worksheets, students are encouraged to make predictions in advance about the results of a mathematical problem or experiment [37], [38]. After that, they carry out observations or experiments to test the correctness of their predictions. The final stage is explanation, where students reveal the results of their observations and explain the mathematical concepts involved. This approach not only builds students' critical thinking and analytical skills, but also helps them better internalize mathematical concepts through hands-on experience. Thus, the use of POE-based student worksheets not only deepens students' understanding of mathematics material, but also increases student motivation and involvement in the learning process [39]. The use of POE-based student worksheets in mathematics learning, especially quadratic equations, is expected to help students understand concepts better [40]. Through systematic and structured activities, students can learn actively and independently, thereby improving their understanding and skills in solving mathematical problems.

Previous relevant research found that POE-based student worksheets had an effect on student learning outcomes in rectilinear motion learning material [41]. Then previous research found that POE-based student worksheet products with a scientific literacy approach were suitable for application in science learning, practical and effective for improving students' communication skills with an N-Gain value of 66.67 at the significance level ($\alpha = 0.05$) [42]. In line with previous research, it was found that the use of POE-oriented student worksheets in learning the concept of pressure in static fluids had a statistically positive influence at the significance level (0.05) with a p-value (0.003) on science process skills, and the effect size ($r = 0.39$) is in the medium category [43]. Previous research gaps focused a lot on science material, such as rectilinear motion and pressure in static fluids. The current research expands the application of POE-based student worksheets into the domain of mathematics, especially in quadratic equations. This opens up opportunities to explore the effectiveness of POE methods in different contexts and assess whether the positive results found in science subjects also apply to mathematics.

The novelty of this research lies in the application of the POE (Predict, Observe, Explain) method through Student Worksheets in the context of mathematics learning, especially in quadratic equations. Although the POE method has been used in various learning fields, its use in mathematics learning is still relatively new, especially

at the upper secondary education level. This research makes a new contribution to the field of mathematics education by proposing an innovative approach aimed at improving students' understanding of complex mathematical concepts such as quadratic equations. Through the application of POE-based student worksheets, students are not only invited to actively participate in the learning process, but are also able to develop their critical and analytical thinking skills [44]. Apart from that, this research also provides practical guidance for teachers in designing and implementing mathematics learning that is more effective and interesting for students. Thus, the novelty of this research lies in the effort to combine innovative learning concepts with conventional mathematics learning contexts, thereby creating a more meaningful and memorable learning experience for students.

This research is important because understanding the concept of quadratic equations is the main basis for learning mathematics. Conventional learning methods are often ineffective in overcoming students' difficulties in understanding this material. By developing innovative approaches such as the use of POE-based Student Worksheets, this research aims to deepen students' understanding effectively and efficiently. With relevance to educational and technological trends, it is hoped that this research can improve the overall quality of mathematics education, as well as increase the competitiveness and quality of human resources in the future. So this research aims to examine the effectiveness of POE-based student worksheets in improving students' understanding of quadratic equation material. By understanding the influence of this method, it is hoped that it can make a positive contribution to the development of more effective and efficient mathematics learning strategies. Apart from that, this research also aims to provide guidance for teachers in designing and implementing POE-based student worksheets as an innovative learning tool.

2. RESEARCH METHOD

This research uses a Mixed Method approach with sequential explanatory type. Mixed Method with sequential explanatory type is a combination of research that combines qualitative and quantitative approaches sequentially [45-47]. The research was conducted in two stages, starting with quantitative data collection and analysis, followed by qualitative data collection and analysis to explain the findings from the previous stage in more depth. This approach provides a comprehensive understanding of the phenomenon under study.

The population in this study were tenth grade high school students at 16 Makassar state high schools. The sample in this study was taken using a simple random sampling technique. The research sample will consist of two groups: an experimental group that will apply learning using POE-based student worksheets, and a control group that will use conventional learning methods. Each group will consist of 30 students.

The data collection technique in this research consists of two types of data, namely quantitative and qualitative data. Quantitative data was obtained from student response questionnaire instruments and student understanding tests on quadratic equation material. Then qualitative data was obtained from structured interviews with teachers and students studying mathematics in grade ten. The response questionnaire grid for students learning by using POE-based worksheets and tests and interviews in this research is presented in tables 1, 2 and 3 below:

Table 1. Student response questionnaire instrument grid for learning by using POE-based worksheets and student understanding tests

Response questionnaire	Essay test
Frequency of Use of POE-Based student worksheets	Identify the Roots of Quadratic Equations
Activities in Learning	Application of the Quadratic Formula
Effectiveness of Using POE student worksheets	Factorization of Quadratic Equations
Confidence Level	Understanding Discriminant Concepts
	Understanding the Concept of Factorization
	Solution to problem

The student response questionnaire consists of 20 statement items with a Likert scale of 4 and the questions consist of 10 essay questions, each of which has a value of 0-10 points. Then the structured interview grid in this research is teaching/learning experiences using POE-based student worksheets, understanding the concept of quadratic equations, and relevance and implications. The categories for student response questionnaires and test questions are as follows.

Table 2. Categories of student responses and student understanding

Response questionnaire		Essay test	
Category	Interval	Category	Interval
Very not good	20-34	Very less	0-19
Not good	35-49	Not enough	20-39
Good	50-64	Enough	40-59
Very good	65-80	Good	60-79

This research data analysis technique uses descriptive statistics and inferential statistics. used the independent sample t test to determine whether there were differences in student understanding between the control and experimental classes. However, there are conditions that must be met for the hypothesis test to be carried out, namely that the data must be normally distributed and homogeneous. Then the qualitative data was analyzed using the Miles and Huberman model.

3. RESULTS AND DISCUSSION

This research aims to evaluate the effectiveness of using POE (Predict, Observe, Explain) based student worksheets in improving students' understanding of quadratic equation material. The following are the results of this research based on quantity and pan data that has been collected and analyzed. This research involved an experimental class using the POE approach with POE-based student worksheets in mathematics learning about quadratic equations, while the control class used conventional methods. Before treatment, a pre-test was carried out to determine the initial abilities of students in both groups. The pre-test results showed that there was no significant difference between the experimental group and the control group, with the average pre-test scores as follows:

Table 3. Description of student pre-test

Class	Experiment	Control
N	30	30
Mean	65.0	63.8

The pre-test results showed that there was no significant difference between the initial abilities of students in the experimental group and the control group. The average pre-test score for the experimental group was 65.0, while the control group was 63.8. This shows that both groups had almost the same initial level of understanding before being given treatment, so that the research results can be more valid in evaluating the effectiveness of using POE-based worksheets. After knowing the students' initial abilities, they continued by giving treatment to the experimental group, namely using POE-based student worksheets on quadratic equation learning material. The following table 4 is the result of the post test, the results of measuring student understanding after 2 meetings using POE-based student worksheet media.

Table 4. Description post test student

Class	Experiment	Control
N	30	30
Mean	87.0	77.8

After treatment, the post-test results showed a significant improvement in the experimental group compared to the control group. The average post-test score for the experimental group was 87.0, while the control group was 77.8. An average increase of 22 points in the experimental group shows that the use of POE-based l is effective in increasing students' understanding of quadratic equation material. The post-test results showed a significant improvement in the experimental group compared to the control group.

3.1. Analysis Descriptive

As for the description response students and understanding student based on descriptive statistical results have been carried out by researchers obtain The results are presented in table 5 below:

Table 5. description response students and understanding student Study with using sheet media Work student POE based

Variable	Intervals	Categories	F	%	Mean	Med	Min	Max
Response	20-34	Very not good	0	0	60.00	64.00	46.00	79.00
	35-49	Not good	2	6.7%				
	50-64	Good	26	86.6%				
	65-80	Very good	2	6.7%				
Understanding	0-19	Very less	0	0	87.00	85.00	59.00	100.00
	20-39	Not enough	0	0				
	40-59	Enough	2	6.7%				
	60-79	Good	18	60%				
	80-100	Very good	10	33.3%				

From these data, it can be concluded that the majority of students feel that using POE-based worksheets is quite effective and provides a good learning experience. The majority of students are in the good category, which shows that the POE method has a positive impact on student motivation and involvement in the learning process. From these data, it can be concluded that the use of POE-based worksheets significantly increases students' understanding of quadratic equation material. The majority of students (60%) are in the good category, and 33.3% of students are in the very good category. This shows that the POE method not only helps students understand the material more deeply, but also improves their overall learning outcomes.

The results of interviews with teachers and students strengthen the statistical results which show that the use of POE-based student worksheets is effective in increasing students' understanding of quadratic equation material. Teachers and students alike report increased understanding of concepts, motivation to learn, and engagement in learning. Students feel more confident and motivated, while teachers see positive changes in the way students understand and apply math concepts. The results of these interviews support quantitative findings that the POE method not only improves student learning outcomes but also provides a more in-depth and enjoyable learning experience.

3.2. Hypothesis testing

Next, to test the hypothesis of this research, namely to find out whether there is a difference in the understanding of students who learn using POE-based student worksheet media and those who use regular learning media. Before testing the independent sample t-test hypothesis, an assumption test was carried out, namely Kolmogorov-Smirnov normality and Levene homogeneity. The results of the normality test obtained a significance value of > 0.05 , which means the data is normally distributed and has a homogeneous variance. Table 6 below is the t test results.

Table 6. T test results

Independent Samples Test				
t-test for Equality of Means				
Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
			Lower	Upper
,040	-6.33333	3.01865	-12.37582	-,29084

From the results of the independent samples t test, it was found that the Sig. (2-tailed) is 0.040, which means it is smaller than 0.05. This shows that there is a significant difference between the experimental group (which used POE worksheets) and the control group (which used conventional methods) in terms of students' understanding of quadratic equation material. The mean difference value is -6.33333, which shows that the average understanding score of students in the experimental group is 6.33333 points higher compared to the control group. The 95% confidence interval for the mean difference is from -12.37582 to -0.29084. Since this interval does not include zero, we can state with a 95% confidence level that this difference is significant.

Overall, the interview results show that the POE method and the use of POE-based worksheets have a positive impact on students' learning experiences and deepen their understanding of quadratic equation material. This provides additional support for the findings from quantitative data analysis, which shows a significant increase in student understanding after using this student worksheet media. The results of this research show that the use of student worksheets based on POE (Predict, Observe, Explain) significantly increases students' understanding of quadratic equation material. Before treatment, there was no significant difference between the initial abilities of students in the experimental group and the control group, indicating that both groups had almost the same initial level of understanding before being given treatment. This ensures that the research results are more valid in evaluating the effectiveness of using POE-based worksheets.

After being given treatment using POE-based worksheets on quadratic equations, the post-test results showed a significant increase in students' understanding in the experimental group compared to the control group. An average increase of 22 points in the experimental group confirms that the use of POE-based student worksheets is effective in increasing students' understanding of quadratic equation material. Descriptive analysis shows that the majority of students feel that using POE-based worksheets is quite effective and provides a good learning experience. The majority of students are in the good category, indicating that the POE method has a positive impact on student motivation and involvement in the learning process. Apart from that, the data also shows that the use of POE-based worksheets significantly increases students' understanding of quadratic equation material.

The results of interviews with teachers and students strengthen the findings from quantitative data analysis. Teachers report positive changes in the way students understand and apply math concepts, while students feel more confident, motivated, and engaged in learning. This confirms that the use of POE-based worksheets not only improves student learning outcomes but also provides a more in-depth and enjoyable learning experience. Hypothesis testing using the independent sample t-test showed that there was a significant difference between the experimental group (which used POE worksheets) and the control group (which used conventional methods) in

terms of students' understanding of quadratic equation material. This difference was found with a 95% confidence level, confirming that the use of POE-based student worksheets effectively increases students' understanding of the material.

Overall, the results of this study conclude that the use of POE-based student worksheets is an effective approach in improving students' understanding of quadratic equation material. This method not only helps students understand the material more deeply but also increases their motivation and involvement in learning mathematics. This research makes a new contribution to the field of mathematics education by testing the effectiveness of using POE-based student worksheets in improving students' understanding of quadratic equation material. This method provides a more interactive and experience-based approach for students, which can increase their engagement and motivation in learning. In addition, the results of this study show that the use of the POE method significantly improves students' understanding of the material, which can be the basis for developing more effective learning strategies in the future.

Previous research shows that the POE learning model can develop students' ideas by connecting experiences or stories that have been obtained previously. Apart from that, students' creativity in using diction is very good when presenting prediction results using the POE method [48]. Previous research found that authentic problem learning packages based on POE (Predict Observe-Explain) are suitable for improving students' critical thinking skills [49]. In previous research, the outcomes measured focused more on cognitive aspects such as critical thinking and creativity in the learning context. This research highlights improvements in overall cognitive function and the relationship between physical activity and cognitive performance, as well as the risk of cognitive decline. This research seeks to reveal the benefits of physical health on mental and cognitive health, providing a more holistic understanding of cognitive well-being.

The novelty of this research provides new insights in the field of mathematics education by showing the significant effectiveness of POE-based student worksheets in improving students' understanding of quadratic equations. In contrast to previous research that primarily focused on the cognitive benefits of the POE method, such as critical thinking and creativity, this research focuses on improving students' overall understanding and engagement with mathematics and we broaden its scope. The research results show that the POE approach not only deepens conceptual understanding but also has a positive effect on students' motivation and engagement in learning.

By integrating POE techniques into the curriculum, educators can create a more interactive and enjoyable learning environment, thereby promoting better educational outcomes. This study provides a new perspective on the practical application of the POE model and provides a basis for future research examining its long-term benefits and broader applicability in different educational contexts. The implications of the results of this research include several aspects. First, the POE method can be an effective alternative in teaching quadratic equations in mathematics classes. Teachers may consider integrating POE-based worksheets in their lesson plans to improve student understanding [50]. Second, the results of this study highlight the importance of paying attention to students' learning experiences in designing effective learning strategies. By providing a fun and interactive learning experience, students can be more involved and motivated in learning mathematics.

Although the results of this study provide valuable insights, several limitations need to be noted. First, this research was conducted in a specific context and with a limited sample, so the generalizability of the results may be limited to certain populations or situations. In addition, measuring student understanding may have limitations in capturing the complexity of their understanding of quadratic equation material as a whole. Furthermore, this study only involved the use of POE-based worksheets during two meetings, so it is unclear whether the effects would persist over a longer period of time. For further research, it is recommended to conduct broader research involving a larger sample and from various student backgrounds. This can increase the generalisability of research results. In addition, longitudinal research can be conducted to understand the long-term effects of using the POE method in mathematics learning.

4. CONCLUSION

The use of POE-based student worksheets significantly increases students' understanding of quadratic equation material. The post-test results showed a significant improvement in the experimental group compared to the control group, with the experimental group's post-test mean score being significantly higher. Thus, the conclusion of this study shows that the use of POE-based student worksheets can be an effective learning strategy in improving students' understanding of quadratic equation material in mathematics classes. This makes an important contribution to the development of mathematics education by paying attention to students' learning experiences and providing a more interactive and experience-based learning approach. For further research, it is recommended to conduct broader research involving a larger sample and from various student backgrounds. This can increase the generalisability of research results. In addition, longitudinal research can be conducted to understand the long-term effects of using the POE method in mathematics learning.

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