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Research Paper

The effect of integrating poh shen loh's approach in improving problem-solving skills of students involving quadratic equation

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ABSTRACT

This study determined the significant effect of integrating Poh Shen Loh's Method on the problem-solving skills of Grade 9 students in quadratic equations. The researchers used a quasi-experimental nonequivalent control group design which included two groups of students who received different teaching methods. The researchers used a researcher-created instrument which had been validated and proved reliable to evaluate student performance through authentic quadratic equation challenges that used Polya's Problem-Solving Steps. The researchers used mean standard deviation t-test and ANCOVA statistical tools to analyze data at a 0.05 significance level. Both the control and experimental groups began their study with equal abilities. The pretest results showed both groups achieved satisfactory performance levels while they showed no statistical difference between them. The experimental group achieved better results than the control group because both groups made progress after their intervention which included moving from satisfactory to outstanding performance. The experimental group achieved higher posttest scores which showed a large effect size because the researchers used ANCOVA to show that Poh Shen Loh's Method explained 78 percent of the students' academic progress. The study found that students who learned through Poh Shen Loh's Method developed better procedural skills and conceptual understanding and visual reasoning and independent problem-solving abilities than those who learned through traditional teaching methods.

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1. INTRODUCTION

Background of the Study

Students must learn to solve quadratic equations and functions because these skills create the base necessary for their upcoming physics engineering, and economics studies according to reference [1]. Students who learn these concepts will gain the ability to make analytical decisions in their daily life. Students face difficulties when they try to solve quadratic equations and functions. The 2023 PISA assessment showed low performance results which proved that many Philippine learners lack understanding of this difficult subject matter. Students encounter difficulties in understanding how to use algebraic formalism because traditional teaching methods which focus on abstract procedures fail to connect theoretical knowledge with real-world applications. The process of learning gets hampered because this separation between two elements makes it impossible for students to develop interest in studying [2], [3].

Performance data reinforce these challenges. The National Career Assessment Examination (NCAE) revealed a steady increase in the number of students scoring low in Mathematics: 11.21% in 2016, 13.87% in 2017, 13.93% in 2018, and 14.10% in 2023. The NCAE results show persistent learning gaps in specific areas because the test assesses algebra and geometry skills which include solving quadratic equations. The diagnostic test results from Caraga Region showed that Grade 9 students performed worse because the percentage of low scorers increased from 23.25% in 2017 to 59.23% in 2022.

The existence of these patterns has been confirmed through local research studies which provide evidence for their occurrence. The Bayugan City Division reported that 35% of students face difficulties in using deductive reasoning to solve quadratic equation problems. The report from 2019 to 2021 showed that 78% of Grade 9 students had major problems when trying to solve these particular problems [4]. The alarming failure rates in the same division show that 72% of students failed during 2021-2022 yet this number increased to 89% during 2022-2023 before it slightly decreased to 69% in 2023-2024 according to MPS-SBM Evaluation.

The research results show that two important research areas and classroom teaching methods face two major issues because there is no research-based instructional method which can help students solve their learning problems [5], [6], [7].

The present study introduces Poh Shen Loh's Method as an alternative way to bridge this educational gap. The method uses constructivist learning theory together with self-regulated problem-solving to teach quadratic problem-solving through conceptual understanding and intuitive reasoning. The strategy will be used to teach Grade 9 mathematics so that students can understand better and achieve higher academic results while developing confidence to solve real-world math problems which will lead to better learning results [8].

2. RELATED WORK

Mathematics education depends on problem-solving because it develops advanced thinking abilities together with self-directed learning abilities and students' understanding of mathematical concepts. Students must complete four distinct problem-solving steps which include understanding the problem together with developing solution strategies and executing their solutions and performing solution evaluation. Students must identify all known and unknown problem elements while they study the problem because they need to know how to handle all quadratic elements which include vertex form and discriminants and roots according to [9].

Students choose suitable methods to solve problems through the strategy and implementation

phases while they apply methods like factoring and completing the square and using the quadratic formula according to [10], [11]. Teachers should support these stages by demonstrating various strategies to students who will decide which strategy works best for them. Quadratic problem solving requires users to perform algebraic manipulations and create graphs while applying their analytical skills and mathematical knowledge to solve real-world and theoretical quadratic challenges according to [12].

Solving quadratic equations presents numerous difficulties which have been extensively documented. Senior secondary students in Nigeria could not use proper solution methods and 87% of students within the study group performed below standard according to results from the study at [13] which demonstrated that students experienced challenges which extended beyond basic understanding of concepts. Students face challenges with traditional teaching methods because these methods do not help students achieve deep understanding of quadratic concepts which they need for practical application in real-life contexts according to [14].

The team developed the Poh Shen Loh Method as a solution to these obstacles which combines constructivist learning approaches with cognitive load theory and strategic problem-solving techniques. This method enables students to learn independently while they use planned methods for studying quadratic functions through practical activities. Active problem investigations through activities enable learners to develop their critical thinking skills together with their ability to solve problems and achieve deeper understanding [15].

The method implementation establishes a connection between self-regulated learning which requires students to manage their learning through independent study and goal setting and self-reflection for better mathematical skills development. During assessment students must check their solutions to confirm they meet both the problem requirements and actual world usage. Effective teaching methods matter because students need to learn how to apply quadratic equations which serve as the base link between algebra and functions and their use in fields like physics and engineering.

Poh Shen Loh's Method offers an innovative, student-centered approach to teaching quadratic equations by emphasizing conceptual understanding over rote memorization [16]. The system uses visual tools which include graphs and diagrams to assist students in understanding intricate relationships while it promotes multiple solution methods that enable students to solve problems through adaptive reasoning together with collaborative learning and real-world usage which helps students comprehend abstract ideas in real-life situations [17]. The method creates opportunities for students to work actively while they practice critical thinking and develop their independence through self-regulated learning methods which lead to better understanding of mathematical concepts and advanced skills in using quadratic knowledge.

Statement of the Problem

The study tested whether the implementation of Poh Shen Loh's Method of Solving Quadratic Equations would improve students' ability to solve quadratic equations. The research took place at Bayugan National Comprehensive High School which falls under the Division of Bayugan City and the Department of Education Agusan del Sur during the School Year 2025-2026. The study specifically aimed to investigate the following research questions.

1. What are the problem-solving skills of students involving quadratic equations of both the control and experimental groups based on their pretest and posttest mean percentage scores?
2. Is there a significant difference in the mean percentage scores between the control and experimental groups in both the pretest and the posttest?
3. Is there a significant difference between the pretest and posttest mean percentage scores within the control group and within the experimental group?
4. Does the integration of Poh Shen Loh's method significantly enhance students' problem-solving skills involving quadratic equations?

Research Null Hypotheses

The following null hypotheses were formulated and tested in the study using a 0.05 level of significance.

H_{01}: There is no significant difference in the mean percentage scores between the control and experimental groups in both the pretest and the posttest.
H_{02}: There is no significant difference between the pretest and posttest mean percentage scores within the control group and within the experimental group.
H_03: The integration of Po-Shen Loh's method does not significantly enhance students' problem-solving skills involving quadratic equations compared to the traditional method.

Theoretical Framework and Conceptual Framework

The study uses constructivist learning theory as its foundation because this theory asserts that students acquire mathematical knowledge through their active participation in learning activities and their ability to solve problems and discover new information. The approach of Poh Shen Loh supports the learning theory because it shows students how to understand current math concepts by recognizing patterns and understanding how the roots and parabola symmetry relate to each other. The traditional teaching method uses a behaviorist approach that requires students to learn through repetition and memorize formulas for all mathematical procedures [18].

The framework defines the instructional method as the independent variable which tests Poh Shen Loh's Approach on the experimental group while using traditional teaching methods on the control group. The methods of instruction determine how students learn and this process leads to the measurement of their problem-solving capabilities in quadratic equations. The researchers used pretests and posttests to establish initial student performance and learning achievements which allowed them to compare different groups in order to assess how Poh Shen Loh's Method impacted students' reasoning skills and engagement levels and their ability to study independently.

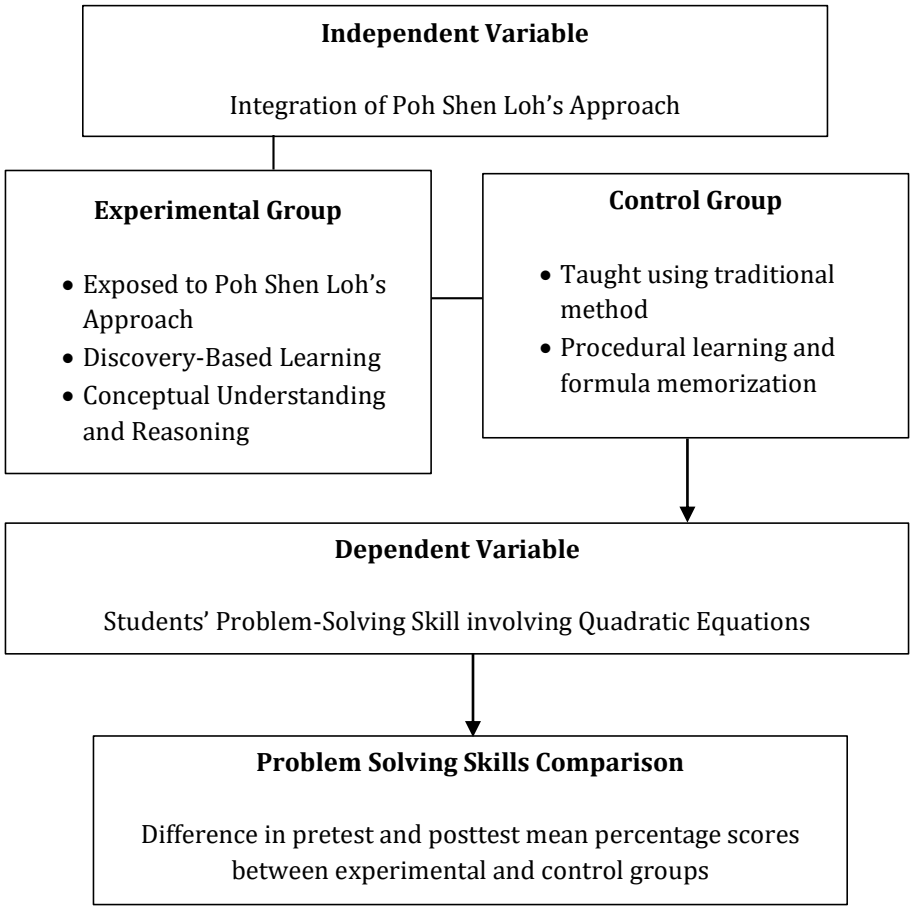


Figure 1. The Conceptual Framework of the Study

Your training data extends until the month of October in the year 2023. The study uses

Figure *1* to show its conceptual framework, which demonstrates how the teaching method affects students' abilities to solve quadratic equations. The independent variable for this study uses two different teaching methods, which include Poh Shen Loh's Approach for the experimental group and traditional teaching methods for the control group.

The learning process of each instructional method shows how it affects students' ability to think about their work. Through guided discovery, the experimental group teaches students to develop reasoning skills and pattern recognition abilities, which leads to their fundamental concept understanding. The study depends on students' use of these processes to develop their problem-solving ability [19].

The framework establishes pretest and posttest assessment methods, which evaluate student performance at two different points, before and after the educational program. The figure demonstrates how different teaching methods impact student learning while showing how Poh Shen Loh's Approach enables students to develop their reasoning skills and learn to solve problems independently.

Significance of the Study

The findings of this study were used as valuable information for people in different areas, especially in education. The results were significant and beneficial to the following:

Students: The study focused on students. The results showed students how to handle challenges that affected their ability to succeed in algebra and geometry. Poh Shen Loh's teaching method helped students to develop both strategic thinking skills and self-directed learning abilities which led them to attain superior knowledge of quadratic equations that resulted in increased mathematics confidence.

Mathematics Teachers: Mathematics Teachers. The research provided educators with an evidence-based instructional strategy which enhanced their ability to teach mathematics in the classroom.

With declining national assessment scores and increasing failure rates in mathematics, the study provided empirical evidence for a structured, engaging, and student-centered method that could be applied in curricula.

School Administrators: The research results enabled administrators to design student intervention programs for trigonometry underperformers while they received guidance to enhance public school educational standards.

Future Researchers: For future researchers this study was acting as a wellspring of data that was being employed to substantiate further study, especially for those who were concerned with similar variables.

Scope and Limitation of the Study

The study evaluated Poh Shen Loh's Method in improving Grade 9 students' problem-solving skills in quadratic equations at Bayugan National Comprehensive High School during SY 2025–2026, comparing it with traditional instruction. The intervention program used four weeks to teach essential quadratic skills which included component identification and factoring and completing the square and using the quadratic formula according to Grade 9 curriculum guidelines that emphasized conceptual understanding and reasoning. The study was limited to one school and Grade level and measured only cognitive performance, with factors like motivation, prior knowledge, and study habits beyond the researcher's control. The findings demonstrate how Poh Shen Loh's Method functions as a valuable teaching tool for mathematics educators.

Definition of Terms

The following terms were defined conceptually and operationally to provide a common understanding of the keywords in this study.

Conventional Way of Instruction: The conventional teaching method which uses chalk and talk requires teachers to deliver knowledge directly to students and test their understanding through assessment methods. The study adopted this approach to use module and textbook materials for lesson delivery in the control group.

Poh Shen Loh's Method: The solution of quadratic equations through Poh Shen Loh's Method uses a modern method which leads to better results because it uses symmetrical patterns together with number

sense to make the root analysis process easier. The study examined instructional sessions which showed students how to solve quadratic equations through this method by providing them with guided examples and practice exercises.

Problem-Solving Skills Involving Quadratic Equations: Problem-solving skills referred to students' ability to understand, represent, formulate, and solve mathematical problems involving quadratic equations [19]. In this study, it referred to students' performance scores in problem-solving tests measured before and after the intervention using Poh Shen Loh's Method.

3. METHODOLOGY

Research Design

The study used a quasi-experimental nonequivalent control group design to collect and analyze numerical data, identify patterns, and determine relationships between variables. In this study, the design measured the effectiveness of Poh Shen Loh's Method by comparing pretest and posttest scores of experimental and control groups. Research demonstrates that this design functions effectively in educational environments because it enables researchers to assess how different educational methods affect student performance.

Research Instrument

The researcher created a five-question assessment tool which evaluated students' abilities to solve quadratic equations based on their capacity to solve problems and their ability to think logically and develop organized solutions. The assessment instrument matched the study framework while measuring both assessment procedures and assessment results. Three experts in mathematics education validated the instrument for content, clarity, and suitability. Inter-rater reliability was excellent (Cohen's Kappa = 0.81–1.00), with only minor revisions made.

A scoring rubric based on Polya's five-step method rated understanding, equation formulation, problem-solving, and interpretation on a 4-point scale (4 = Excellent to 1 = Needs Improvement). The system classified student performance results into four categories, which included Outstanding, Very Satisfactory, Satisfactory, and Poor, thereby providing complete feedback about students' reasoning abilities and their capacity to solve problems correctly.

Research Locale and Respondents

The research was performed at Bayugan National Comprehensive High School through the initial grading period of the academic year 2025-2026. The researchers selected 104 Grade 9 students from Sections Aquamarine and Turquoise because of their poor performance in mathematics. A coin toss randomly assigned one section as the experimental group and the other as the control group.

Data Gathering Procedures

The study followed institutional research standards at Davao del Norte State College (DNSC) and underwent evaluation by the Research Ethics Review Committee for informed consent, confidentiality, and ethical treatment of participants. The Dean of IADS issued a Notice to Commence which the research team used to start their study after sending their formal request through letters to the principal and Mathematics Department Head and Division Education Program Supervisor. The experimental phase used different teaching methods to instruct both groups in quadratic equations with the experimental group following Poh Shen Loh's Method which focused on organized reasoning and the control group using standard teaching methods.

Experimental Phases

The pre-experimental phase required a pre-test which the researchers administered to both groups that contained 52 students each. The researchers spent five weeks on lesson preparation which included curriculum reviewing and material development and lesson finalization to ensure research

objectives were met. The experimental phase used different teaching methods to instruct both groups in quadratic equations with the experimental group following Poh Shen Loh's Method which focused on organized reasoning and the control group using standard teaching methods. The researchers used classroom observations to maintain teaching methods and student active participation while they measured student problem-solving proficiency as the main research variable.

The researchers conducted a post-experimental phase which used a post-test that mirrored the pre-test to evaluate student mastery, conceptual understanding, and procedural fluency, and problem-solving abilities. The researchers used a standardized rubric to assess student responses which three experts had validated, while they measured the effectiveness of Poh Shen Loh's Method through mean gain scores and paired t-tests and effect sizes.

Statistical Treatment of Data

The researchers used descriptive and inferential statistical methods to assess the effectiveness of Poh Shen Loh's Method which they applied to improve students' ability to solve quadratic equation problems. Descriptive statistics use mean and standard deviation with mean percentage scores to describe performance which shows average scores and score variability and group proficiency levels across different groups. The researchers used independent samples t-tests to compare pretest and posttest scores between groups and paired samples t-tests to measure within-group improvements and they used ANCOVA to control pretest differences while evaluating the method's impact. The researchers used an alpha level of 0.05 to determine whether they should accept or reject null hypotheses while they showed evidence for the method's effectiveness.

Ethical Considerations

The research study fully followed all established ethical standards. The researchers obtained informed consent from students and their parents or guardians after they received all necessary school authority approvals according to institutional guidelines. The researcher used coded data which only he could access to maintain confidentiality and anonymity of the study participants. The research team monitored student well-being while providing equal academic support to all students and they created comparable student groups based on pre-test results to maintain non-maleficence and beneficence and equity and justice principles. The researchers maintained transparency through their procedure explanations which included sharing study results with others.

4. RESULTS AND DISCUSSION

Problem-solving skills of students involving quadratic equations of both the Control and Experimental Groups based on their Pretest and Posttest Mean Percentage Scores. Table 1 presents the descriptive statistics of the pretest and posttest mean percentage scores (MPS) of the control and experimental groups to determine the students' problem-solving skills in quadratic equations.

Table 1. Problem Solving Skills of Students Involving Quadratic Equations of both the Control and Experimental Groups Based on their Pretest and Posttest Mean Percentage Scores

Pre-Test			Post-Test			
Groups	MPS	SD	Descriptive Equivalent	MPS	MPS	Descriptive Equivalent
Control Group	43.06	5.33	Satisfactory	59.90	5.01	Satisfactory
Experimental Group	44.60	4.47	Satisfactory	82.96	7.18	Outstanding

Both groups showed significant improvement. The control group experienced an MPS increase

from 43.06 to 59.90 which still met "satisfactory" standards because the group achieved procedural improvements. The experimental group showed MPS growth from 44.60 to 82.96 which reached "outstanding" status because of Poh Shen Loh's reasoning-based discovery-oriented educational technique. The SD increase from 4.47 to 7.18 demonstrated that people developed distinct abilities to handle the procedure.

An independent samples t-test shown in Table 2 was conducted to compare the mean percentage scores (MPS) of the control and experimental groups before and after the intervention. H_{01} stated that there was no significant difference in pretest scores and that there was no significant difference in posttest scores.

Table 2. Test of Significance in the Difference of the Pretest and Posttest Mean Percentage Scores between the Control and Experimental Groups

Test	Group	MPS	SD	T-Value	P-Value	Decision @ α = 0.05
Pretest	Control	43.06	5.33	1.594	0.114	H_{01} Not Rejected
	Experimental	44.60	4.47			
Posttest	Control	59.90	5.01	18.998	0.000	H_{01} Rejected
	Experimental	82.96	7.18			

The pretest results showed no significant difference between the groups, indicating comparable baseline problem-solving skills and supporting the validity of attributing posttest gains to the intervention, consistent with prior findings on common initial algebra difficulties [20]. The posttest findings demonstrated a strong experimental group advantage because students who studied Poh Shen Loh's Method achieved better results and understood concepts more deeply than control group members who only showed slight progress which matched studies about reasoning-based student-centered teaching methods.

Researchers used paired samples t-tests in Table 3 to assess whether each group showed significant progress between pretest and posttest. H_02 stated that there is no significant difference between the pretest and posttest mean percentage scores within the control group and within the experimental group.

Table 3. Test of Significance in the Difference between the Pretest and Posttest Mean Percentage Scores of the Control and Experimental Groups

Group	Test	MPS	SD	T-Value	P-Value	Decision @ α = 0.05
Control	Pretest	43.06	5.33	15.960	0.000	H_{02} Rejected
	Posttest	59.90	5.01			
Experimental	Pretest	44.60	4.47	39.171	0.000	H_{02} Rejected
	Posttest	82.96	7.18			

For the control group, scores increased from 43.06 to 59.90, with a slight reduction in standard deviation, indicating more consistent performance. The research showed statistically significant results which proved that regular teaching methods helped students develop problem-solving abilities but their performance only reached "satisfactory" standards. Traditional teaching methods enhance procedural fluency according to established research but they restrict students' ability to develop complete conceptual knowledge which innovative methods enable [20].

The experimental group showed a much larger increase, from 44.60 to 82.96, moving students from “satisfactory” to “outstanding.” The t-value obtained from this study reached a highly significant level because students who learned through Poh Shen Loh's Method showed major improvements in their problem-solving abilities together with advanced knowledge development and improved thinking capacities. The 40-point achievement increase provides evidence which supports previous studies that demonstrate how structured student-centered teaching methods which emphasize reasoning enable students to achieve significant comprehension of algebra concepts [21].

Test whether the Integration of Poh Shen Loh's Method Significantly Enhance Students' Problem Solving Skills Involving Quadratic Equations after Controlling the Pretest

Before running ANCOVA, all assumptions, including normality, homogeneity of variances, linearity, and homogeneity of regression slopes, were satisfied, ensuring the validity of the analysis. This answered the H_{03} which states that the integration of Po-Shen Loh's method does not significantly enhance students' problem-solving skills involving quadratic equations compared to the traditional method.

Table 4 shows the adjusted posttest means after controlling for pretest scores. Students taught using Poh Shen Loh's Method obtained a significantly higher adjusted mean score (M = 82.83, SE = 0.86) than those taught through the conventional method (M = 60.04, SE = 0.86), p = .000, showing a substantial difference of nearly 23 points.

Table 4. Test whether the Integration of Poh Shen Loh's Method Significantly Enhance Students' Problem-solving Skills Involving Quadratic Equations after Controlling the Pretest

Estimates Dependent Variable: Posttest					
Taxonomy of Domain	**Mean**	**Std. Error**	**95% C.I. Lower**	**P-Value Upper**	**Decision on @ = 0.05**
Control	60.041[a]	0.859	58.336	61.745	0.000 H_{03} Rejected
Experimental	82.825[a]	0.859	81.121	84.529	

[a] Covariates appearing in the model are evaluated at the following values: Pretest = 43.83

Significant Difference in Posttest Mean Percentage Scores between the Experimental and Control Groups after Controlling for Pretest

The experimental group showed higher adjusted posttest results than the control group after researchers controlled for their initial test scores. The instructional method produced a highly significant impact according to the ANCOVA results because Poh Shen Loh's Method accounted for 78% of the posttest score variance. The investigation proved $H_0 3$ to be false.

Table 5. ANCOVA Test of Significant Difference in Posttest Mean Percentage Scores between the Experimental and Control Groups after Controlling for Pretest

Source	SS	DF	MS	F	P	H^2P
Pretest	78.15	1	78.15	2.06	.154	.02
Group	13169.08	1	13169.08	347.43	<.001	.78
Error	3828.29	101	37.90			

Note. η^2p = partial eta squared.

Table 5 showed confirmation of the significant effect of the intervention, F(1, 101) = 347.43, p < .001, η^2p = .78, indicating that 78% of the variance in posttest scores was explained by the instructional method. The study found that pretest scores failed to serve as effective predictors of posttest results for students.

The research established that Poh Shen Loh's Method delivered significant benefits to students by improving their problem-solving abilities and their understanding of quadratic equations beyond their existing knowledge.

5. CONCLUSION

The chapter ties all each research question to the results, concluding with some general recommendations on how to respond or what the future requires.

Both groups performed at the same level because their score on the "satisfactory" range matched between the experimental group and control group. The study results proved that educational methods

were responsible for the observed progress.

Both groups exhibited improved problem-solving abilities in quadratic equations after the experiment, yet the experimental group achieved superior results which proved that Poh Shen Loh's Method effectively enhanced their understanding of concepts and their ability to perform skills.

The study results demonstrate that organized teaching methods with structured teaching methods lead to better mathematics learning results. The experimental approach proved to be more effective than both teaching methods because it better developed students' advanced thinking skills and their ability to solve problems. The study demonstrates how innovative student-centered teaching methods create value for Mathematics education.

Recommendations

The following recommendations arise from the study results.

Mathematics teachers may adopt Poh Shen Loh's Method to improve student performance in solving quadratic equations and other problem-solving topics. The educational system needs to develop lessons that integrate collaborative student learning through structured lesson plans and organized activities which teachers can use during School-Based Learning Action Cell (LAC) sessions to implement the method.

The implementation of this approach requires school administrators to provide professional development training seminarsand workshops to support its execution. Educational resources should contain books and digital materials and manipulatives and activities that enable students to develop visual reasoning skills while exploring multiple solution pathways and exercising independent learning.

School administrators and educational leaders from the Department of Education work together to create classroom settings that promote positive learning experiences for all students. The assessment process needs to evaluate students' understanding and their ability to solve complex problems and apply knowledge to real-world situations, while learning outcomes and observations and student feedback should be used for ongoing assessment of educational methods.

Further studies are required in various areas of mathematics across levels of instruction so as to assess confidently the broader effectiveness of the Poh Shen Loh's method and support its implementation in K–12 mathematics curriculum.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Orvin A. Lobitos	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓		
Ma Melanie N. Edig		✓	✓	✓		✓	✓			✓		✓		✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

The study was conducted in compliance with the ethical principles outlined in the Declaration of Helsinki and approved by the relevant institutional authorities.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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