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Developing the Ability to Solve Mathematics Problems 'Polygons', Through Open Approach Learning Management for Sixth-Grade Students

Pitchayapa Moungwandee[1] & Yannapat Seehamongkon [2]

[1] Master student, Master of Education (Curriculum and Instruction), Mahasarakham University, Mahasarakham, Thailand

[2] Faculty of Education, Mahasarakham University, Mahasarakham, Thailand

Correspondence: Yannapat Seehamongkon, Faculty of Education, Mahasarakham University, Thailand 44000.

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Abstract

This action research aims to develop the ability to solve mathematical problems, particularly in polygons, through open-approach learning management for sixth-grade students, with the goal of achieving an average score exceeding 70% of the total possible score. The target group consisted of eight students in the second semester of the academic year 2023. Data collection tools included lesson plans, mathematics problem-solving ability tests, student behavior observation forms, and student journal logs. The data were analyzed using statistical methods, including percentages, means, and standard deviations. The findings showed that an open approach to learning management can effectively enhance mathematical problem-solving skills. Furthermore, it was observed that the students demonstrated various problem-solving approaches, actively engaged in group and inter-group learning exchanges, displayed confidence in problem-solving, and improved their mathematical problem-solving abilities.

Keywords: open approach, mathematics problem-solving, action research

1. Introduction

The National Educational Test (O-NET) results from 2020–2022 highlighted significant challenges in mathematics at Bandonduwangbon School. The school's average scores in algebra and numbers, geometry and measurement, and mathematics and statistics were notably below the national averages, indicating a need for urgent curricular improvements. In particular, the Measurement and Geometry domain recorded the lowest average score of 23.86 out of 100, far below the school's 70 percent benchmark. Researchers, examining these outcomes, identified that students struggled the most with polygon problems. Over three years (2021–2023) of teaching experience, it was evident that students faced difficulties in understanding, planning, and solving polygon-related questions. They could often identify the correct formulas but failed to execute solutions effectively. These findings highlight the necessity for enhanced instructional strategies to improve problem-solving skills in mathematics. By focusing on these areas, educators can help students build a stronger foundation and achieve better outcomes.

The researcher aims to develop a teaching strategy for sixth graders at Bandonduwangbon School who encounter challenges in deconstructing and solving math problems using systematic problem-solving approaches. Effective problem-solving not only leads to learning but also applies experience to analyze, discover, and implement solutions. Students can engage in organized learning activities focused on thinking processes and analysis to identify the reasons behind difficulties and explore various solutions. Learning management serves as a tool to enhance competence in solving mathematical problems. The "Open Approach," a learning management system prioritizing learners' needs, offers students opportunities to encounter scenarios or challenges that foster analytical thinking, synthesis, problem-solving comprehension, and other abilities. This approach recognizes that solutions are not necessarily singular but emerge after addressing multiple perspectives. In an open teaching method, educators grasp the concepts or rationale behind responses without constraining students' thought processes. This teaching approach encourages students to autonomously navigate problem-solving processes. Group interactions promote understanding of the knowledge-creation process through collaborative participation, enabling students to construct knowledge independently. Teachers employing open teaching methods strive to comprehend students' perspectives, fostering complex thinking in mathematical activities through negotiation and guidance, thereby

opening students' minds to mathematics (Nohda, 2000).

2. Review Literature

2.1 Open Approach

Open Approach is a method of teaching that focuses on the learner. It is teaching that emphasizes having the learner develop knowledge and put it into practice or do every step until self-learning occurs and it is teaching that emphasizes allowing students to learn how to acquire knowledge, which requires learning processes and many types of teaching techniques (Nohda, 2000). Develop students' mathematical thinking potential by using open-ended problem-solving activities. It includes three key themes: students' open minds about mathematics, openness, and problem types and evaluating student answer guidelines (Inprasitha, 2014). Open Approach is used as a teaching method that emphasizes the problem-solving process with a 4-step teaching sequence as follows 1) Presentation of open-ended problems Make that problem a student problem 2) Students' self-learning. It allows students to learn on their own while students are solving problems and learning together with others 3) Whole class discussion and comparison. It brings together various ideas of students. Let's discuss this as a whole class so that other students can understand. In class we had the opportunity to learn from our friends' ideas 4) Summarizing by connecting students' ideas that occurred in class is an expansion concept by expanding concepts by making connections from various concepts of students that occur in the classroom (Inprasitha, 2011).

2.2 Mathematics Problem Solving

The process of solving mathematical problems is divided into 4 steps (Polya, 1975)

1) Understanding the problem involves identifying what needs to be known, defining the data required, understanding the conditions of the problem, and ensuring these conditions are adequate for correct resolution. If there is ambiguity or conflict in understanding, it is beneficial to visually represent the situation or conditions through diagrams. This process helps to break down the problem into manageable parts and further clarify its structure.

2) Devising a plan involves identifying connections between information and the desired knowledge or outcome.

3) Carrying out the plan involves executing each step meticulously, ensuring that each step is verified for accuracy.

4) Looking back involves verifying the correctness of the problem-solving process. This includes checking if the results align with expectations and considering alternative methods to cross-verify the initial findings, such as using random estimates or conducting further checks.

2.3 Action Research

Action research cycle model (Kemmis, 1988)

Step 1: Plan to begin with collectively exploring the issues within the school environment to identify key problems that need addressing. This involves delving into the specifics of each issue, including its nature, who determines it, and preliminary action plans. We rely on forecasting the expected outcomes from implementing plans, considering the involvement of stakeholders. Additionally, we may examine past events to anticipate potential outcomes and assess supporting or hindering factors affecting successful implementation. Flexibility in adapting to situations that may arise during the execution process is crucial, ensuring alignment with the evolving circumstances.

Step 2: Translating conceptual ideas into actionable plans often leads to deviations from the intended course during implementation. Therefore, it is crucial to collectively analyze and evaluate the challenges and obstacles encountered by the team. This collaborative effort aims to address and refine the predefined plans. Flexibility within these plans allows practitioners to adapt to real-world conditions. Additionally, effective implementation requires continuous systematic action, guided by decisions on whether to adhere to the original plan or adjustment. Temporary assumptions may arise during execution, which could change over time as circumstances evolve.

Step 3: Observe involves a thorough examination of changes that occur, encompassing both expected and unexpected occurrences. Utilizing data collection tools and observations helps in this process. Supporting factors and obstacles to plan implementation are identified. Effective observation requires proactive planning with a scope that is neither too broad nor too narrow, guiding reflecting on the outcomes of actions taken. Operational flexibility is essential to adapt to various circumstances, being receptive and understanding.

Step 4: Reflecting on and evaluating problem-solving processes or constraints in research operations, conducted collaboratively with relevant stakeholders, involves examining issues from various perspectives. This includes critical thinking, process analysis, and the outcomes of implementing predetermined plans. The evaluation

meticulously considers the relationship with the societal context, the school environment, and the educational system within which the operations are conducted. Through thorough discussion and debate, problems in the evaluation process are identified, providing insights for developing activity improvement strategies. This information is then used for refining and planning future operational activities.

This research is an action research project aimed at enhancing the ability of sixth-grade students to solve mathematics problems, particularly in polygons, through the implementation of open approach learning management. The goal is for students to achieve at least 70% of the full score.

3. Method

The methodology used in this research is action research, based on Kemmis and McTaggart's (1988) concept, aimed at developing the ability to solve mathematics problems, particularly in the topic of polygons, through open approach learning management for sixth-grade students to achieve at least 70% of the full scores.

3.1 Target Group

There are 8 students in the second semester of the academic year 2023. The researcher considered the following criteria:

1) Male or female, age 11–12 years

2) Currently studying in Grade 6 at Bandonduwangbon School

3) Lack of ability to solve mathematics problems in the topic "Polygons".

3.2 Tools

Evaluation tools

1) Mathematics lesson plans

2) Mathematics problem–solving ability test

Reflective tools

1) Student's behavior observation form

2) Journal log for student form

4. Data Collection

Step 1: The researcher developed a research tool comprising lesson plans based on data gathered from learners' academic performance and relevant literature. The quality of this tool was then assessed by having specialists review it after the lesson plans were implemented.

Step 2: The researcher employed both quantitative (e.g., math problem-solving exams) and qualitative (e.g., behavior observation forms and student diary logs) data collection techniques. In the data analysis, the gathered data was categorized into quantitative and qualitative data. Using fundamental statistics and observations of the students' learning patterns, the researcher examined the data.

Step 3: The researcher documented the students' capacity for problem-solving while observing the process of setting up learning activities utilizing an open approach.

Step 4: To enhance learning activities and organize operations for the subsequent cycle, the researcher collaborated with advisers and other researchers to analyze, assess, discuss, and reflect on the data gathered from the preceding steps.

5. Data Analysis

In this research, the collected data was analyzed using both quantitative and qualitative methods. Quantitative data was analyzed using basic statistics such as percentage, mean, and standard deviation.

1) Quantitative analysis involved finding the mean and percentage of test scores measuring the ability to solve math problems. These scores were then compared to the specified criteria, which required an average score of no less than 70 percent of the full score for each test set.

2) Qualitative data analysis involved examining the content of the tools used to reflect on research practice results. The researcher used this data to evaluate conditions, identifying any defects, problems, or obstacles that occurred. Based on these findings, the researcher sought ways to improve and develop the learning activities for future iterations, which led to a discussion of the research results.

6. Results and Discussion

Results of measuring the mathematics problem-solving abilities test of sixth-grade students after using open approach learning management.

Table 1. Scores of students' ability to mathematics problem solving after using open approach in Cycle 1

Cycle 1				
Ability	Mean	S.D.	percentage	Passed (students)
mathematics problem solving	25.00	12.33	50.00	3

Table 1 shows that the mean score for problem-solving abilities in the first cycle was 25.00 out of 50.00 points. This represents 50% of the full score, which is less than the stated criteria of 70% of the full score. It was observed that while students' interest in the tasks and their aptitude for solving mathematical problems increased, there were no group discussions, and some group members did not support one another. The issue is that students are still acclimating to the open approach and have not yet met the criteria. They wrote incorrect symbolic sentences due to uncertainty in applying problem-solving techniques. The results of measuring the ability to solve polygon problems from the mathematics problem-solving test of sixth-grade students after using open approach learning management.

Table 2. Scores of students' ability to mathematics problem solving after using open approach in Cycle 2

Cycle 2				
Ability	Mean	S.D.	percentage	Passed (students)
mathematics problem solving	34.38	11.20	68.76	5

According to Table 2, the mean score for problem-solving abilities in the second cycle was 34.63 out of 50.00 points, or 66.76% of the full score. This is still below the 70% cutoff set as the target. It was observed that students became more conscientious about working in pairs, felt more at ease collaborating, paid attention to the teacher's feedback, and adjusted accordingly. Additionally, students demonstrated improved proficiency in solving mathematical problems. The findings from evaluating sixth-grade students' proficiency with polygon problems on a mathematics problem-solving exam, following the use of open-approach learning management.

Table 3. Scores of students' ability to mathematics problem solving after using open approach in Cycle 3

Cycle 33				
Ability	Mean	S.D.	percentage	Passed (students)
mathematics problem solving	38.00	11.46	76.00	6

According to Table 3, the mean score for problem-solving abilities in the third cycle was 38.00 out of 50.00 points, equivalent to 76% of the full score, meeting the required standards. It was observed that students have become more proficient in solving mathematical problems and are developing their collaboration skills. Additionally, there is increased support within the group.

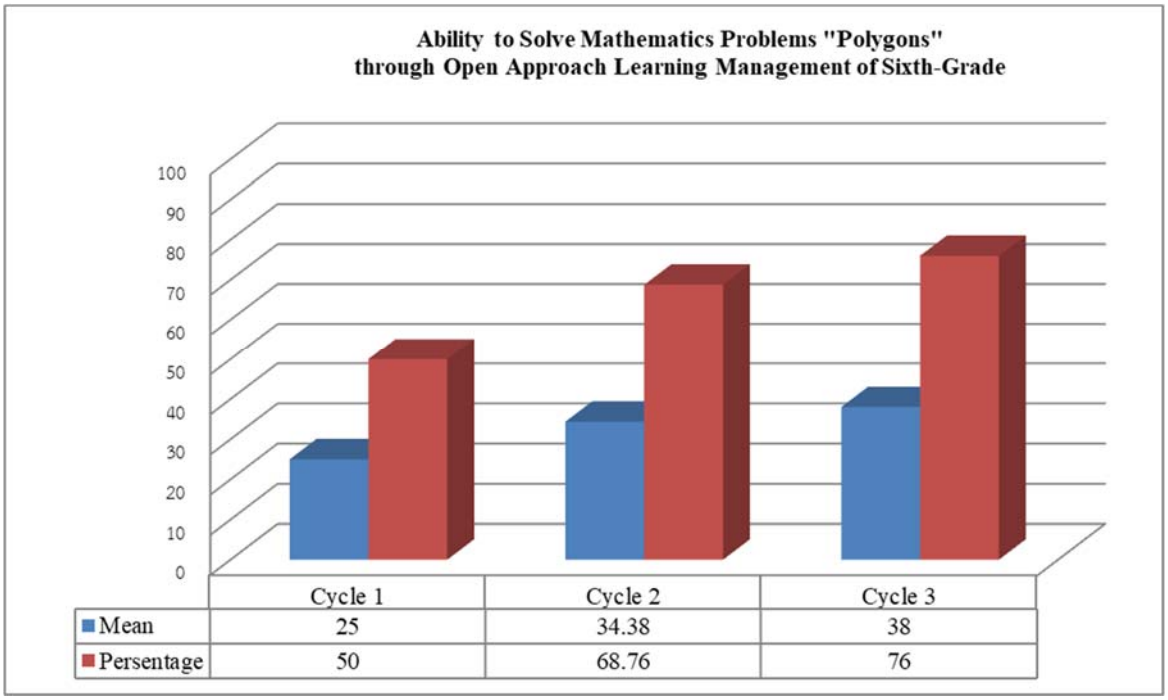

Figure 1. Ability to solve mathematics problems "Polygons" through open approach learning management

Researchers conducted activities in Cycle 1 using open approach learning management and observed the following: 1) Students exhibited increased interest in provided scenarios or issue statements. 2) The mean score was 25.00 out of 50.00 points, equivalent to 50% of the full score, indicating improvement in students' problem-solving skills. However, this fell short of the 70% threshold, with only 37.5% of the total students (3 out of 8) meeting passing requirements. Primary challenges included students' unfamiliarity with open approach learning management and difficulties in organizing their problem-solving approaches. Some students executed mathematical processes incorrectly yet achieved accurate answers. This indicates a grasp of the issue but errors in mathematical application, leading to suboptimal results when tackling problems. Additionally, students often remained silent and did not support peers during activities due to a lack of confidence in expressing their ideas.

Researchers observed in Cycle 2 that: 1) Students collaborated more effectively. 2) The mean score for students' problem-solving skills increased to 34.38 out of 50.00 points, representing 68.76% of the full score. However, this still fell short of the predetermined 70% threshold, with only 27% of students (5 out of 8) passing. The primary issue was that students' problem-solving approaches did not align with the provided examples, leading to misunderstandings. Despite this, students demonstrated increased comfort in voicing their ideas and participating actively throughout the activities.

Researchers found in Cycle 3 that: 1) Students demonstrated improved cooperation abilities and increased support for one another within groups. 2) The mean score was 38.00 out of 50.00 points, or 76% of the full score, indicating enhanced problem-solving abilities. This surpassed the 70% benchmark, with 75% of students (6 out of 8) achieving passing scores. Despite some students continuing to make errors in mathematical processes, they displayed effort and improvement in solving problems. Most students exhibited increased confidence in expressing their ideas during activities, along with enhanced problem-solving skills.

7. Conclusion

Development is facilitated through open approach learning management. Students who engage in solving arithmetic problems related to "Polygons" using this approach are more likely to become self-reflective, persistent, and motivated learners. Encouraging students to be confident in their problem-solving abilities involves fostering creativity and encouraging them to explore diverse approaches within the classroom setting.

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Authors contributions

Pitchayapa Moungwandee was responsible for the research design, data collection, and manuscript drafting. Assoc. Prof. Dr. Yannapat Seehamongkon reviewed the research and provided advice to ensure its successful completion. Assoc. Prof. Dr. Prasart Nuangchalerm offered suggestions for publication.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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