



EXPLORING THE EFFECTIVENESS OF PROBLEM-BASED LEARNING ON GRADE 8 STUDENTS' ANALYTICAL THINKING SKILLS

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ABSTRACT

This study determined the effectiveness of Problem-Based Learning (PBL) in strengthening the analytical thinking skills of Grade 8 students. A quantitative one-group pretest-posttest pre-experimental design was used with 89 Grade 8 students enrolled during the 2025–2026 academic year in a private school in Labason, Zamboanga del Norte. A researcher-developed 50-item multiple-choice analytical skills test, validated by experts and pilot-tested with comparable learners, was administered before and after a 10-week PBL intervention. The intervention involved two approximately one-hour sessions per week using authentic, age-appropriate problems, collaborative investigation, teacher facilitation, evidence evaluation, solution development, presentation, and reflection. Frequency, percentage, mean, and standard deviation were used to describe performance, while a paired-samples t-test at the .05 significance level tested the difference between pretest and posttest scores; Cohen's d was used to estimate effect magnitude. The pretest mean was 28.18 (SD = 6.59), interpreted as Did Not Meet Expectations, whereas the posttest mean increased to 37.26 (SD = 7.07), interpreted as Satisfactory. The paired-samples t-test showed a statistically significant difference, $t(88) = -10.28$, $p < .001$, with a large effect size (Cohen's $d = 1.09$). The findings indicate that the structured PBL intervention was associated with substantial improvement in the analytical thinking performance of the participating Grade 8 students.

Keywords: *Problem-Based Learning, analytical thinking, Grade 8 students, pretest-posttest design, higher-order thinking*

INTRODUCTION

Education in the 21st century places increasing emphasis on developing learners who can analyze information, solve problems, make reasoned judgments, and apply knowledge in meaningful situations. Analytical thinking is essential because it enables students to examine information, identify relationships, evaluate evidence, and arrive at logical conclusions. These skills are particularly important among Grade 8 students as they encounter increasingly complex concepts, word problems, and learning tasks that require higher-order thinking rather than simple recall.

Problem-Based Learning (PBL) is a student-centered approach that engages learners in meaningful and often real-world problems requiring investigation, analysis, collaboration, and the formulation of possible solutions. Instead of merely receiving information from the teacher, students actively construct understanding by examining problems and applying what they have learned. PBL has been associated with critical thinking, problem solving, collaboration, and other higher-order thinking outcomes (Daud et al., 2024; Seibert, 2020; Theabthueng et al., 2022).

Analytical thinking is closely associated with higher-order thinking and includes processes such as differentiating, organizing, recognizing relationships, evaluating evidence, and drawing logical conclusions. PBL corresponds with these processes because students determine what they know, identify what they need to learn, investigate possible explanations, evaluate information, and develop defensible solutions (Hmelo-Silver, 2004; Syaiful et al., 2021). Evidence from studies involving secondary and junior high school learners also indicates that structured PBL activities can support analytical and related thinking skills (Daud et al., 2024; Seituni et al., 2023; Theabthueng et al., 2022).

The relationship between PBL and analytical thinking can be understood through Constructivist Learning Theory, Sociocultural Theory, and Metacognitive Theory. Constructivist perspectives emphasize that learners actively construct knowledge through experience and interaction with their environment (Piaget, 1964, 1980). Vygotsky's (1978) Sociocultural Theory highlights learning through social interaction, peer collaboration, and teacher scaffolding within the Zone of Proximal Development. Metacognitive Theory emphasizes learners' awareness and regulation of their own thinking, including planning, monitoring, and evaluating problem-solving processes (Flavell, 1979). Together, these perspectives explain how PBL may strengthen analytical thinking through active knowledge construction, social interaction, and reflective regulation.

Recent literature further suggests that the effectiveness of PBL depends on implementation conditions. Students' readiness, motivation, collaborative abilities, available instructional time, and teacher facilitation can influence outcomes. Structured collaboration, appropriate scaffolding, reflection, and meaningful problems are therefore important features of effective PBL implementation (Amerstorfer & Frein von Münster-Kistner, 2021; Guo et al., 2024; Sappaile et al., 2025). PBL has also been reported to support problem solving and creative thinking when combined with appropriate learning supports (Simanjuntak et al., 2021).

Despite these findings, much of the literature has focused on critical thinking as a broader construct, while less attention has been given specifically to analytical thinking among Grade 8 students. Analytical thinking involves breaking down information, recognizing relationships, distinguishing relevant evidence, and using these elements to reach logical solutions. There is therefore a need for context-specific evidence on whether a structured PBL intervention can significantly improve these skills among Grade 8 learners.

The study is relevant to Sustainable Development Goal 4 (SDG 4), which promotes inclusive and equitable quality education and meaningful learning outcomes. Developing analytical and problem-solving skills through learner-centered approaches such as PBL supports the goal of equipping students with competencies needed for further learning and participation in a changing society.

Given this need, the present study sought to determine the effectiveness of Problem-Based Learning in strengthening the analytical thinking skills of Grade 8 students. Specifically, it examined students' analytical thinking skills before and after the PBL intervention and determined whether a significant improvement occurred. The findings may provide empirical support for the use of PBL and contribute to learner-centered teaching practices in junior high school education.

Research Questions

This study sought to determine the effectiveness of Problem-Based Learning in strengthening the analytical skills of Grade 8 students. Specifically, it sought to answer the following research questions:

1. What was the level of the Grade 8 students' analytical skills before the intervention?
2. What was the level of the Grade 8 students' analytical skills after the intervention?
3. Was there a significant difference between the Grade 8 students' analytical skills before and after the intervention?

METHODOLOGY

The study employed a quantitative one-group pretest-posttest pre-experimental design to determine the effectiveness of Problem-Based Learning (PBL) in strengthening the analytical skills of Grade 8 students. The same group was assessed before and after the intervention. The pretest established the students' baseline analytical skills, while the posttest determined changes following the PBL intervention. Because no control group was included, the findings are interpreted within the limitations of the pre-experimental design.

The study was conducted in a private school in Labason, Zamboanga del Norte, Philippines, during the 2025–2026 academic year. Approximately 89 Grade 8 students from three Grade 8 sections participated in the study. The participants were selected using convenience sampling, based on their accessibility and availability to participate in

the study. Participation was voluntary and required parental or guardian consent and student assent because the participants were minors.

A researcher-developed 50-item multiple-choice test was used to measure analytical skills before and after the intervention. The test contained age-appropriate problems and situations primarily drawn from Grade 8 Science and Mathematics. Items assessed the ability to interpret problems, identify relevant information, apply appropriate reasoning, analyze information and evidence, and draw logical conclusions.

The instrument underwent expert validation to establish relevance, clarity, developmental appropriateness, and alignment with Grade 8 competencies and analytical skills. After the validators' recommendations were incorporated, the instrument was pilot-tested among 30 to 40 Grade 8 students with characteristics similar to the participants but who were not included in the actual study. Item analysis was conducted, and internal consistency reliability was established, with a coefficient of 0.70 or higher considered acceptable. The source document does not report the final reliability coefficient; this value should be inserted if available.

The PBL intervention was implemented over 10 weeks, with two sessions per week lasting approximately one hour each. Before implementation, the teacher was oriented on PBL principles and procedures, including development of age-appropriate problems, facilitation of collaborative learning, classroom management, and assessment of student outputs. Activities were aligned with selected Grade 8 competencies and used authentic, open-ended problems requiring students to analyze information, examine evidence, and develop possible solutions.

During the first week, students were oriented to the PBL process and administered the pretest. They were organized into heterogeneous groups of four to five members, with group norms and responsibilities established to promote productive collaboration. From the second to the ninth week, students engaged in a structured PBL cycle involving presentation of a real-life problem, identification of what they knew and needed to investigate, information gathering, analysis and synthesis, development of solutions, evidence-based justification, presentation, feedback, and reflection. The teacher served as a facilitator by providing guidance and asking probing questions that encouraged students to explain their reasoning, examine evidence, and consider alternatives. During the tenth week, the posttest was administered, and reflection activities were conducted. Implementation logs, observation checklists, student outputs, and participation records were used to monitor intervention implementation.

Frequency, percentage, mean, and standard deviation were used to describe students' analytical skills before and after the intervention. A paired-samples t-test was employed to determine whether a significant difference existed between pretest and posttest scores at the .05 level of significance. Cohen's d was computed to determine the magnitude of the intervention effect.

The scope of the study was limited to the 89 participating Grade 8 students in a private school in Labason, Zamboanga del Norte, the 10-week intervention, and the researcher-developed analytical skills test. The absence of a control group limits causal inference, and the findings may not be generalizable to other grade levels, schools, or learner populations. The study also relied on a single pretest-posttest assessment and therefore does not establish whether gains were sustained over time.

RESULTS

Pre-intervention analytical skills

Table 1 presents the Grade 8 students' analytical thinking skills before implementation of the PBL intervention. Most students (46 or 51.69%) were classified as Did Not Meet Expectations, followed by 27 (30.34%) at the Fairly Satisfactory level, 15 (16.85%) at the Satisfactory level, and 1 (1.12%) at the Very Satisfactory level. No student reached the Outstanding level. The pretest mean was 28.18 (SD = 6.59), interpreted as Did Not Meet Expectations.

Table 1.

Descriptive Statistics of the Grade 8 Students' Analytical Thinking Skills Pre-test Performance

Score Range	Interpretation	Frequency	Percentage
45–50	Outstanding	0	0.00
40–44	Very Satisfactory	1	1.12
35–39	Satisfactory	15	16.85
30–34	Fairly Satisfactory	27	30.34
Below 30	Did Not Meet Expectations	46	51.69
Total		89	100.00
Score Range	Interpretation	Frequency	Percentage
	Mean	28.18	
	Interpretation	Did Not Meet Expectations	
	Standard Deviation	6.59	

Post-intervention analytical skills

Table 2 presents the students' analytical thinking skills after the PBL intervention. The largest group was at the Satisfactory level (22 students or 24.72%), followed by Fairly Satisfactory (21 or 23.60%), Very Satisfactory (20 or 22.47%), and Outstanding (17 or 19.10%). Only 9 students (10.11%) remained in the Did Not Meet Expectations category. The posttest mean was 37.26 (SD = 7.07), interpreted as Satisfactory.

Table 2.

Descriptive Statistics of the Grade 8 Students' Analytical Thinking Skills Post-test Performance

Score Range	Interpretation	Frequency	Percentage
45–50	Outstanding	17	19.10
40–44	Very Satisfactory	20	22.47
35–39	Satisfactory	22	24.72
30–34	Fairly Satisfactory	21	23.60
Below 30	Did Not Meet Expectations	9	10.11
Total		89	100.00
Score Range	Interpretation	Frequency	Percentage
	Mean	37.26	
	Interpretation	Satisfactory	
	Standard Deviation	7.07	

Difference between pretest and posttest scores

Table 3 shows that the mean score increased from 28.18 (SD = 6.59) in the pretest to 37.26 (SD = 7.07) in the posttest, an increase of 9.08 points. The paired-samples t-test yielded $t(88) = -10.28$, $p < .001$. The null hypothesis was rejected. Cohen's d was approximately 1.09, indicating a large effect size.

Table 3.

Test of Difference Between Pre-test and Post-test Scores

Variables	Mean	SD	t-value	df	p-value	Decision	Interpretation
Pre-test	28.18	6.59	-10.28	88	< .001	Reject H_0	Significant
Post-test	37.26	7.07					

DISCUSSION

The pretest results indicate that the participating Grade 8 students began the study with generally limited analytical thinking performance. The mean score of 28.18 was classified as Did Not Meet Expectations, and 82.03% of students were in either the Did Not Meet Expectations or Fairly Satisfactory categories. This baseline supports the need for learning experiences that move students beyond recall and provide repeated opportunities to examine information, identify relationships, and reason through problems.

The improvement observed in the posttest is consistent with the central rationale of PBL. The mean increased by 9.08 points, while the proportion of students classified as Did Not Meet Expectations decreased from 51.69% to 10.11%. The proportion reaching Satisfactory, Very Satisfactory, or Outstanding performance increased from 17.97% to 66.29%. These changes suggest that the intervention was associated with improvement

in the analytical competencies measured by the assessment, including interpreting problems, identifying relevant information, applying reasoning, analyzing information and evidence, and drawing justified conclusions.

The statistically significant paired-samples t-test result, $t(88) = -10.28$, $p < .001$, together with a large Cohen's d of 1.09, indicates that the pretest-posttest difference was substantial in this group. The result is consistent with literature describing PBL as an approach that promotes active investigation, problem solving, collaboration, and higher-order thinking (Hmelo-Silver, 2004; Seibert, 2020). It is also consistent with studies reporting improvements in analytical or related thinking skills among learners exposed to PBL (Marlina et al., 2025; Seituni et al., 2023; Syaiful et al., 2021; Theabthueng et al., 2022).

The pattern of improvement may also be explained by the intervention's emphasis on authentic problems, collaborative inquiry, teacher questioning, evidence evaluation, presentation, and reflection. These features provide opportunities for students to construct knowledge through experience, learn through interaction with peers and a facilitator, and monitor their own thinking processes (Flavell, 1979; Piaget, 1964; Vygotsky, 1978). The use of scaffolding and collaboration is likewise consistent with literature emphasizing the importance of student-teacher relationships, reflective learning, and appropriate support in PBL settings (Amerstorfer & Frein von Münster-Kistner, 2021; Guo et al., 2024; Sappaile et al., 2025).

The findings should nevertheless be interpreted cautiously. Because the study used a one-group pretest-posttest pre-experimental design without a control group, improvements cannot be attributed exclusively to PBL with the same level of confidence as in a controlled or randomized design. Other factors, including normal learning progression, exposure to classroom instruction, or familiarity with the assessment, may have contributed to the observed gains. The results therefore provide evidence of improvement following the intervention within the study context rather than definitive causal evidence that PBL alone produced the change. This limitation is important when considering application to other learners or settings.

The findings also align with broader evidence that problem-based and collaborative approaches can support problem solving and higher-order thinking when implementation is appropriately structured (Daud et al., 2024; Simanjuntak et al., 2021). Thus, the present results add context-specific evidence concerning Grade 8 analytical thinking while reinforcing the importance of careful problem selection, facilitation, collaboration, and reflection in PBL implementation.

Conclusions

First, the Grade 8 students demonstrated limited analytical thinking skills before the intervention, with a mean pretest score of 28.18 ($SD = 6.59$), interpreted as Did Not Meet Expectations.

Second, after the 10-week PBL intervention, the students' analytical thinking performance improved to a mean posttest score of 37.26 (SD = 7.07), interpreted as Satisfactory.

Third, there was a statistically significant difference between the pretest and posttest scores, $t(88) = -10.28$, $p < .001$, with a large effect size (Cohen's $d = 1.09$). Within the limits of the research design, the findings indicate that the PBL intervention was associated with substantial improvement in the analytical thinking skills of the participating Grade 8 students.

Recommendations

Problem-Based Learning may be sustained and further integrated into Grade 8 instruction, particularly in lessons requiring analytical thinking, problem solving, interpretation of information, and evidence-based reasoning.

Teachers may use authentic and age-appropriate problems that encourage students to examine information, explore possible solutions, justify their reasoning, and reflect on their learning processes. Appropriate scaffolding and structured collaboration should be maintained, especially for learners who are less familiar with independent inquiry.

Particular attention may be given to the 9 students (10.11%) who remained in the Did Not Meet Expectations category after the intervention. Additional scaffolding, differentiated PBL activities, guided practice, and closer monitoring may help address their learning needs.

Schools may provide opportunities for teachers to strengthen their competence in designing and facilitating PBL activities and explore their application in other Grade 8 learning areas. Future studies may use larger samples, comparison or control groups, and longer follow-up periods to examine whether improvements in analytical thinking are sustained and whether similar results occur across other grade levels and learning contexts.

Compliance with Ethical Standards

The study complied with ethical standards for research involving student participants. Approval from the appropriate school authorities was secured before data collection. Parents or legal guardians provided informed consent, and the participating students provided assent. Participation was voluntary, and participants were informed of their right to withdraw without negative consequences.

Anonymity and confidentiality were maintained through participant codes, secure handling of research data, and aggregate reporting, and participation or non-participation did not affect students' grades or academic standing.

The researchers safeguarded the well-being of the participants, avoided conflicts of interest, and sought to prevent bias in the interpretation of findings. Plagiarism was strictly avoided, and the results were used solely for research purposes.

Furthermore, the researchers disclosed that artificial intelligence (AI) tools were used only in the drafting, organizing, and improving the language of portions of the research manuscript. The researchers retained responsibility for the accuracy, interpretation, and final content of the paper. AI tools were not used to fabricate, manipulate, or falsify research data, results, or findings.

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