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Project-Based Integration Approach on the Learners' Mathematical Learning Skills and Performance

John Michael Gabis Losañez
Laguna State Polytechnic University Sta. Cruz Laguna 4009 PHILIPPINES
Email address: julierosemendoza002@gmail.com

Abstract*—This study, entitled "Project-Based Integration Approach on Learners' Mathematical Learning Skills and Performance," aimed to determine the effect of the project-based integration approach on learners' mathematical learning skills and performance. Specifically, the study sought to find the level of the project-based integration approach in terms of curiosity and exploration, interdisciplinary focus, real-world relevance, reflective process, and assessment focus; the level of learners' mathematical learning skills in terms of problem-solving ability, mathematical reasoning, numeracy proficiency, and mathematical fluency. It also assess the level of learners' performance in terms of practical and written tests. Moreover, the significant effect of the project-based integration approach on learners' mathematical learning skills and performance were measured. This study employed a descriptive-correlational research design to analyze the relationships between project-based integration and learners' mathematical learning skills and performance. The respondents were 79 Grade 9 students from Dapdap Integrated School, Tayabas City, during the third quarter of S.Y. 2024–2025. The level of the project-based integration approach was very high across curiosity and exploration, interdisciplinary focus, real-world relevance, reflective process, and assessment focus. Similarly, learners' mathematical learning skills, including problem-solving ability, mathematical reasoning, numeracy proficiency, and mathematical fluency, were also rated at a very high level. In terms of performance, learners achieved a very satisfactory rating in practical tests and an outstanding rating in written tests, indicating stronger performance in written assessments. Furthermore, multiple regression analysis revealed that the project-based integration approach did not have a statistically significant effect on learners' mathematical learning skills and performance. Based on the findings, the following conclusions were hereby drawn. Project-based integration approach did not have a statistically significant effect on learners' mathematical learning skills and performance resulting to the acceptance of both hypotheses. Therefore, the lack of a significant effect of the project-based integration approach on learners' mathematical skills and performance may be due to various influencing factors. This indicates that further research is needed to better understand when and how project-based learning can effectively support students in improving their math skills. In the formulated conclusions from the findings, it was recommended that Mathematics teachers refine the implementation of project-based learning by incorporating structured problem-solving tasks that directly reinforce mathematical skills. Learners should actively engage in project-based learning to develop problem-solving, reasoning, and numeracy skills. Future researchers may explore additional factors such as instructional strategies, cognitive load, and student motivation to further enhance the effectiveness of project-based learning in mathematics education.*

Keywords*—Project-Based Integration, curiosity and exploration, interdisciplinary focus, real-world relevance, reflective process.*

I. INTRODUCTION

Mathematics education is essential in developing students' problem-solving skills, logical reasoning, and critical thinking. However, traditional teaching methods often make mathematics feel disconnected from real-world applications, leading to decreased engagement and difficulty in retention. To address this, innovative teaching approaches, such as Project-Based Learning (PBL), have been explored to enhance students' mathematical learning skills and performance.

The Project-Based Integration Approach (PBIA) is a teaching method that connects mathematics with real-world projects, encouraging students to explore, analyze, and apply concepts in meaningful ways. This approach bridges the gap between theory and practice by engaging learners in hands-on activities that require collaboration, problem-solving, and critical thinking. Through PBL, students see the relevance of mathematics in everyday life, which improves their motivation and academic achievement.

Additionally, PBL encourages creativity by allowing students to develop their own strategies for solving mathematical problems. It fosters collaboration, as students work in groups to discuss and apply mathematical concepts. Moreover, PBL helps students develop a growth mindset, where mistakes are seen as learning opportunities rather than failures. The ability to work through challenges independently and as part of a team prepares students not only for academic success but also for real-world problem-solving.

This study seeks to examine how the Project-Based Integration Approach influences mathematical learning skills and academic performance. By analyzing student engagement, problem-solving ability, and academic outcomes, this research aims to provide evidence-based insights into the effectiveness of PBL in mathematics education.

1.1 Statement of the Problem

Problem/s which were addressed by the research

The primary objective of this study is to determine the influence of the Project-Based Integration Approach on the Learners' Mathematical Learning Skills and Performance in Mathematics.

Specifically, it aims to answer the following questions:

1. What is the level of the Project-Based Integration Approach in terms of:
   1.1 Curiosity and exploration;
   1.2 Interdisciplinary focus;
   1.3 Real world relevance;

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1.4 Reflective process; and
1.5 Assessment focus
2. What is the level of learners' mathematical learning skills in terms of:
2.1 Problem-solving Ability;
2.2 Mathematical Reasoning;
2.3 Numeracy Proficiency; and
2.4 Mathematical Fluency?
3. What is the level of learners' performance in terms of:
3.1 Practical Test; and
3.2 Written Test?
4. Does the Project-Based Integration Approach have a significant effect on learners' mathematical learning skills?
5. Does the Project-Based Integration Approach have a significant effect on learners' performance in mathematics?

II. Methodology

This study employed a descriptive-correlational research design to analyze the relationships between project-based integration and learners' mathematical learning skills and performance. The respondents were 79 Grade 9 students from Dapdap Integrated School, Tayabas City, during the third quarter of S.Y. 2024–2025. The level of the project-based integration approach was very high across curiosity and exploration, interdisciplinary focus, real-world relevance, reflective process, and assessment focus. Similarly, learners' mathematical learning skills, including problem-solving ability, mathematical reasoning, numeracy proficiency, and mathematical fluency, were also rated at a very high level. In terms of performance, learners achieved a very satisfactory rating in practical tests and an outstanding rating in written tests, indicating stronger performance in written assessments. Furthermore, multiple regression analysis revealed that the project-based integration approach did not have a statistically significant effect on learners' mathematical learning skills and performance.

III. Results and Discussion

This part presents, analyzes, and interprets the data gathered that showed a significant effect of project-based integration approach have a significant effect on learners' mathematical learning skills and performance in mathematics.

Level of Project-Based Integration Approach

The level of the project-based integration approach refers to curiosity and exploration, interdisciplinary focus, real world relevance, reflective process and assessment focus, was treated statistically using mean and standard deviation.

Table 1 presents the level of the project-based integration approach in terms of curiosity and exploration, as reflected in various statements along with their corresponding mean, standard deviation, and remarks.

The computed weighted mean of 4.65 with a standard deviation of 0.54 indicates that the project-based integration approach fosters a very high level of curiosity and exploration among learners.

The strong agreement across all indicators suggests that students perceive project-based activities as highly engaging, motivating them to explore mathematical ideas, investigate problems independently, and recognize connections between different mathematical concepts.

Furthermore, the findings imply that project-based learning enhances students' ability to apply mathematical principles beyond the classroom, reinforcing their enthusiasm for learning.

TABLE 1. Level of the Project-Based Integration Approach in Terms of Curiosity and Exploration

STATEMENTS…	MEAN	SD	REMARKS
I am encouraged to ask questions and explore new mathematical ideas during project-based activities.	4.52	0.55	Strongly Agree
The activities stimulate my curiosity and motivate me to learn more about mathematics.	4.82	0.42	Strongly Agree
I feel more engaged when I am given the opportunity to investigate mathematical problems independently.	4.67	0.52	Strongly Agree
Project-based learning helps me discover connections between different mathematical concepts.	4.68	0.59	Strongly Agree
The projects inspire me to apply mathematics beyond the classroom.	4.56	0.61	Strongly Agree
Weighted Mean	4.65		
SD	0.54		
Verbal Interpretation	Very High		

Overall, this highlights the critical role of project-based learning in fostering curiosity, independent thinking, and problem-solving skills. By providing opportunities for exploration and real-world application, project-based activities empower students to take an active role in their learning, thereby deepening their understanding and engagement with mathematics.

Hunaepi et al. (2024) emphasize that curiosity serves as a cognitive tool that drives deeper learning, particularly in problem-based settings. Similarly, Shin (2024) found that high levels of curiosity positively impact self-regulated learning, improving academic outcomes.

These findings support the notion that integrating project-based learning can cultivate students' interest in mathematics and enhance their critical thinking abilities.

Table 2 presents the level of the project-based integration approach in terms of interdisciplinary focus, as reflected in various statements along with their corresponding mean, standard deviation, and remarks.

The computed weighted mean of 4.55 with a standard deviation of 0.51 indicates a very high level of interdisciplinary focus in project-based learning. The strong agreement across all indicators suggests that students recognize the value of integrating mathematics with other disciplines, such as science, technology, and economics. This integration enhances their understanding of mathematical concepts and strengthens their problem-solving skills across multiple subjects. Additionally, the findings highlight that students appreciate mathematics more when they see its real-world relevance in various academic fields.

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TABLE 2. Level of the Project-Based Integration Approach in Terms of Interdisciplinary Focus

STATEMENTS…	MEAN	SD	REMARKS
The projects integrate mathematics with real-world applications from other subjects.	4.58	0.52	Strongly Agree
I understand mathematical concepts better when they are linked to other disciplines (e.g., science, technology, economics).	4.59	0.49	Strongly Agree
Working on interdisciplinary projects helps me develop problem-solving skills that apply to multiple subjects.	4.52	0.50	Strongly Agree
The project tasks allow me to apply knowledge from different fields to solve mathematical problems.	4.54	0.53	Strongly Agree
I appreciate mathematics more when I see its relevance in various subjects.	4.53	0.50	Strongly Agree
Weighted Mean	4.55		
SD	0.51		
Verbal Interpretation	Very High		

Overall, this underscores the importance of an interdisciplinary approach in mathematics education. By linking mathematical concepts with real-world applications and other disciplines, project-based learning promotes deeper comprehension, critical thinking, and the ability to apply knowledge in diverse contexts.

Oudenampsen et al. (2023) emphasize that interdisciplinary learning fosters cognitive flexibility, critical thinking, and problem-solving skills by integrating knowledge from various fields. Similarly, Chandra (2023) highlights that interdisciplinary education strengthens students' ability to analyze complex problems by synthesizing information from multiple disciplines, leading to more meaningful learning experiences.

TABLE 3. Level of the Project-Based Integration Approach in Terms of Real World Relevance

STATEMENTS…	MEAN	SD	REMARKS
The projects provide meaningful real-world applications of mathematical concepts.	4.85	0.46	Strongly Agree
I feel that what I learn in project-based tasks is useful in my daily life.	4.76	0.54	Strongly Agree
I can relate project-based math tasks to real-life situations.	4.56	0.64	Strongly Agree
I understand mathematical concepts better when they are applied in practical settings.	4.86	0.35	Strongly Agree
Project-based learning helps me see the importance of mathematics in solving real-world challenges.	4.82	0.42	Strongly Agree
Weighted Mean	4.77		
SD	0.48		
Verbal Interpretation	Very High		

Table 3 presents the level of the project-based integration approach in terms of real-world relevance, as shown in the various statements along with their corresponding mean, standard deviation, and remarks.

The computed weighted mean of 4.77 with a standard deviation of 0.48 indicates a very high level of real-world relevance in project-based learning. The strong agreement across all indicators suggests that students perceive project-based tasks as highly applicable to their daily lives, allowing them to connect mathematical concepts to real-life situations. The highest-rated statement, "I understand mathematical concepts better when they are applied in practical settings" (4.86), underscores the significance of contextual learning in mathematics education.

Overall, this highlights the role of real-world relevance in enhancing mathematical understanding and appreciation. By integrating authentic applications, project-based learning makes mathematics more meaningful, engaging, and practical, helping students recognize its importance in solving real-world challenges.

According to Knoster and Goodboy (2021), relevance-based teaching strategies improve student engagement by making learning materials more applicable to their interests and needs. Similarly, Erselcan (2021) emphasizes that experiential learning enhances students' confidence and skills by incorporating real-world experiences into classroom instruction, reinforcing the practical value of education.

Level of the Project-Based Integration Approach in Terms of Reflective Process

Table 4 presents the level of the Project-Based Integration Approach in terms of the reflective process, as indicated by various statements with their corresponding mean, standard deviation, and remarks.

TABLE 4. Level of the Project-Based Integration Approach in Terms of Reflective Process

STATEMENTS…	MEAN	SD	REMARKS
I am encouraged to reflect on my learning and understanding of mathematical concepts after completing a project.	4.81	0.51	Strongly Agree
The activities help me evaluate my strengths and areas for improvement in mathematics.	4.84	0.41	Strongly Agree
I feel more confident in mathematics when I analyze and assess my own learning progress.	4.80	0.49	Strongly Agree
I learn from my mistakes and adjust my approach in future mathematical tasks.	4.73	0.55	Strongly Agree
Reflection after project completion helps me retain mathematical concepts for longer periods.	4.61	0.61	Strongly Agree
Weighted Mean	4.76		
SD	0.51		
Verbal Interpretation	Very High		

The computed weighted mean of 4.76 with a standard deviation of 0.51 indicates a very high level of reflective practice in project-based learning. The strong agreement across all statements suggests that students actively reflect on their learning experiences, recognize their strengths and areas for improvement, and make necessary adjustments in future tasks.

The highest-rated statement, "The activities help me evaluate my strengths and areas for improvement in mathematics" (4.84), highlights the importance of self-assessment in fostering confidence and long-term retention of mathematical concepts.

Overall, this underscores the role of reflection in deepening mathematical understanding. By engaging in self-evaluation, students develop critical thinking, enhance

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problem-solving strategies, and reinforce their mathematical knowledge, leading to greater academic success.

According to Tai et al. (2022), inclusive evaluation strategies that incorporate reflection promote deeper learning by allowing students to assess their progress meaningfully. Similarly, Machost and Stains (2023) emphasize that reflective practices improve adaptability and teaching effectiveness, fostering a learning environment where students can critically analyze and refine their mathematical skills.

TABLE 5. Level of the Project-Based Integration Approach in Terms of Assessment focus

STATEMENTS…	MEAN	SD	REMARKS
Project-based assessments allow me to demonstrate my understanding of mathematical concepts effectively.	4.53	0.53	Strongly Agree
I prefer project-based assessments over traditional written tests.	4.57	0.52	Strongly Agree
The grading criteria for project-based activities are clear and fair.	4.54	0.50	Strongly Agree
I feel motivated to perform well in mathematics when assessed through projects.	4.44	0.50	Strongly Agree
My creativity and critical thinking skills improve through project-based assessments.	4.48	0.53	Strongly Agree
Weighted Mean	3.51		
SD	0.52		
Verbal Interpretation	Very High		

Table 5 presents the level of the Project-Based Integration Approach in terms of assessment focus, as reflected in the given statements with their corresponding mean, standard deviation, and remarks.

The computed weighted mean of 4.51 with a standard deviation of 0.52 indicates a very high level of assessment focus in project-based learning. The strong agreement across all statements suggests that students perceive project-based assessments as an effective means of demonstrating their mathematical understanding. The highest-rated statement, "I prefer project-based assessments over traditional written tests" (4.57), highlights students' preference for assessments that allow them to apply their learning creatively and critically rather than relying solely on written exams.

Overall, these findings emphasize the effectiveness of project-based assessments in enhancing student motivation, engagement, and deeper comprehension of mathematical concepts. By incorporating hands-on tasks and performance-based evaluations, students develop essential problem-solving and critical thinking skills.

According to Zhang (2023), project-based learning significantly enhances students' higher-order thinking abilities, including creative problem-solving and integrated application skills.

Similarly, Márquez et al. (2023) highlight that transparent and well-structured assessment tools improve student participation and academic performance, making project-based evaluation an effective alternative to traditional testing methods.

Learners' Mathematical Learning Skills

The level of learners' mathematical learning skills in terms of problem-solving ability, mathematical reasoning, numeracy proficiency and mathematical fluency, was treated statistically using mean and standard deviation.

Table 6 presents the level of learners' mathematical learning skills in terms of problem-solving ability, as reflected in various statements along with their corresponding mean, standard deviation, and remarks.

TABLE 6. Level of Learners' Mathematical Learning Skills in Terms of Problem-Solving Ability

STATEMENTS…	MEAN	SD	REMARKS
I can analyze and solve mathematical problems more effectively through project-based learning.	4.51	0.50	Strongly Agree
I develop different strategies to solve mathematical problems in project tasks.	4.56	0.50	Strongly Agree
I feel more confident in tackling challenging math problems after completing projects.	4.49	0.55	Strongly Agree
Project-based tasks help me break down complex problems into simpler step	4.54	0.50	Strongly Agree
I enjoy solving real-world problems that require mathematical solutions.	4.52	0.53	Strongly Agree
Weighted Mean	4.52		
SD	0.52		
Verbal Interpretation	Very High		

The computed weighted mean of 4.52 with a standard deviation of 0.52 indicates a very high level of problem-solving ability among learners when engaged in project-based learning. The very high level of agreement suggests that students perceive project-based learning as an effective approach to improving their analytical skills and ability to develop multiple strategies for solving mathematical problems. Furthermore, the results indicate that students feel more confident in tackling challenging problems and are better equipped to break down complex mathematical tasks into simpler steps.

Overall, this implies that project-based learning plays a significant role in strengthening students' problem-solving skills by fostering deeper engagement, logical thinking, and the ability to apply mathematical concepts in real-world contexts. This highlights the importance of active learning approaches in developing essential mathematical competencies.

According to Bayarcal & Tan (2023), open-ended and project-based approaches enhance students' engagement and problem-solving efficiency by allowing them to explore multiple solutions. Similarly, Mršnik et al. (2023) highlighted that mathematical problem-solving exercises equip students with essential skills to tackle real-life challenges. Malangtupthong et al. (2023) further emphasized that instructional strategies, self-efficacy, and reduced math-related anxiety contribute to improved problem-solving abilities, which project-based learning effectively fosters.

Table 7 presents the level of learners' mathematical learning skills in terms of mathematical reasoning, as reflected in various statements along with their corresponding mean, standard deviation, and remarks.

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TABLE 7. Level of Learners' Mathematical Learning Skills in Terms of Mathematical Reasoning

STATEMENTS…	MEAN	SD	REMARKS
I can explain my mathematical reasoning clearly in project-based activities.	4.65	0.48	Strongly Agree
I am encouraged to justify my solutions when working on mathematical projects.	4.47	0.50	Strongly Agree
The projects help me improve my logical thinking and reasoning skills.	4.54	0.50	Strongly Agree
I can connect previous mathematical knowledge to new concepts during project work.	4.53	0.50	Strongly Agree
I feel more capable of explaining mathematical ideas to my peers.	4.58	0.52	Strongly Agree
Weighted Mean	3.55		
SD	0.50		
Verbal Interpretation	Very High		

The computed weighted mean of 4.55 with a standard deviation of 0.50 indicates a very high level of mathematical reasoning among learners engaged in project-based integration.

The results imply that students strongly agree that project-based activities help them articulate their mathematical reasoning, justify their solutions, and connect prior knowledge to new concepts.

This highlights the effectiveness of project-based learning in fostering logical thinking and enhancing students' ability to explain mathematical ideas to their peers.

Overall, these findings imply that project-based integration fosters mathematical reasoning by providing students with opportunities to engage in meaningful discussions, justify their solutions, and build connections between mathematical concepts. Encouraging students to express their reasoning helps deepen their understanding, reinforcing the importance of logic and analysis in problem-solving.

Rohati et al. (2023) stated that mathematical reasoning skills involve various cognitive levels, where students develop deeper analytical abilities through problem-solving and structured learning experiences. Similarly, Ilyas et al. (2022) emphasized that interdisciplinary approaches, such as STEM integration, significantly improve critical thinking and reasoning skills by engaging students in real-world mathematical applications.

Level of Learners' Mathematical Learning Skills in Terms of Numeracy Proficiency

Table 8 presents the level of learners' mathematical learning skills in terms of numeracy proficiency, as reflected in various statements along with their corresponding mean, standard deviation, and remarks.

The computed weighted mean of 4.75 with a standard deviation of 0.45 indicates a very high level of numeracy proficiency among learners engaged in project-based integration.

The results imply that students strongly agree that project-based activities enhance their ability to perform calculations accurately, interpret numerical data, and apply mathematical concepts in real-life scenarios. This implies that project-based learning provides meaningful opportunities for students to reinforce their basic mathematical skills while improving their confidence in handling numbers across different contexts.

TABLE 8. Level of Learners' Mathematical Learning Skills in Terms of Numeracy Proficiency

STATEMENTS…	MEAN	SD	REMARKS
I can perform calculations accurately and efficiently in project-based activities.	4.80	0.40	Strongly Agree
My ability to interpret and analyze numerical data improves through project tasks.	4.73	0.44	Strongly Agree
I feel more confident when working with numbers in different mathematical contexts.	4.66	0.55	Strongly Agree
The projects help me practice and reinforce my basic math skills.	4.76	0.43	Strongly Agree
I can apply numerical concepts effectively in real-life scenarios.	4.78	0.41	Strongly Agree
Weighted Mean	4.75		
SD	0.45		
Verbal Interpretation	Very High		

Overall, these findings imply that project-based integration plays a crucial role in developing numeracy proficiency by engaging students in hands-on activities that require accurate computation, data analysis, and real-world application of numerical concepts. Strengthening numeracy skills through project-based learning fosters a deeper understanding of mathematical principles and their relevance in everyday life.

Celemin (2023) stated that numeracy skills are fundamental to problem-solving and decision-making, enabling students to navigate complex mathematical situations with confidence. Similarly, Hoogland (2023) emphasized that integrating numeracy into real-world applications enhances students' ability to analyze and interpret data, making mathematics more meaningful and practical.

Table 9 presents the level of learners' mathematical learning skills in terms of mathematical fluency, as reflected in various statements along with their corresponding mean, standard deviation, and remarks.

TABLE 9. Level of Learners' Mathematical Learning Skills in Terms of Mathematical Fluency

STATEMENTS…	MEAN	SD	REMARKS
I can recall and apply mathematical concepts quickly when needed in projects.	4.58	0.65	Strongly Agree
My speed and accuracy in solving math problems have improved through project-based learning.	4.75	0.44	Strongly Agree
The projects help me practice essential math skills repeatedly until I master them.	4.54	0.57	Strongly Agree
I feel more comfortable solving complex problems after working on math projects.	4.68	0.47	Strongly Agree
My overall mathematical fluency has improved due to project-based learning.	4.72	0.45	Strongly Agree
Weighted Mean	4.66		
SD	0.52		
Verbal Interpretation	Very High		

The computed weighted mean of 4.66 with a standard deviation of 0.52 indicates a very high level of mathematical fluency among learners engaged in project-based learning. The results imply that students strongly agree that project-based activities enhance their ability to recall and apply mathematical concepts quickly, improve their speed and

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accuracy in problem-solving, and provide repeated practice that leads to mastery. This implies that project-based learning helps students build confidence in tackling complex problems, reinforcing their fluency in mathematical computations and logical reasoning.

Overall, these findings imply that project-based integration significantly contributes to the development of mathematical fluency by offering opportunities for students to engage in meaningful practice, improve accuracy, and apply their learning efficiently. Strengthening fluency through project-based learning allows students to approach mathematical tasks with greater ease and competence. Gliksman et al. (2022) stated that mathematical fluency is developed through consistent practice and exposure to problem-solving tasks, enabling students to retrieve and apply mathematical knowledge efficiently. Similarly, Tikhomirova & Malykh (2017) emphasized that fluency in mathematics is essential for mastering higher-order skills and reducing anxiety in problem-solving situations.

Learners' Performance

The level of learners' performance in terms of practical test and written test was treated statistically using the frequency and percentage.

Table 10 presents the level of learners' performance in terms of the practical test. It includes the score ranges, frequency, percentage, and corresponding remarks.

Out of the 79 respondents, the majority (27 students or 34.18%) scored between 13-16, which falls under the Very Satisfactory category. This was followed by 26 students (32.91%) who scored between 9-12, classified as Satisfactory. Meanwhile, 22 students (27.85%) attained scores between 17-20, categorized as Outstanding. A small number of students (4 or 5.06%) scored between 5-8, which is considered Fairly Satisfactory. Notably, no student scored within the 0-4 range, meaning none were classified under Did Not Meet Expectation.

TABLE 10. Level of Learners' Performance in Terms of Practical Test

Scores	Frequency	Percentage	Remarks
17-20	22	27.85%	Outstanding
13-16	27	34.18%	Very Satisfactory
9-12	26	32.91%	Satisfactory
5-8	4	5.06%	Fairly Satisfactory
0-4	0	0.00%	Did Not Meet Expectation
Total	79	100%	

Weighted Mean = 13.97

The overall weighted mean score was 13.97, with a standard deviation of 3.01. These results indicate that most students performed at a Very Satisfactory level in the practical test, demonstrating a generally competent grasp of the required skills.

According to Zulkifli et al. (2022), active participation in learning activities, such as hands-on projects and interactive demonstrations, enhances students' engagement and comprehension. Likewise, Herlina & Ahmad (2022) emphasized that experiential learning approaches, including practical applications, foster deeper understanding and problem-solving abilities among learners. These findings imply that incorporating project-based learning strategies can significantly improve students' practical performance by reinforcing mathematical concepts through real-world applications.

Table 11 presents the level of learners' performance in terms of the written test. It includes the score ranges, frequency, percentage, and corresponding remarks.

TABLE 11. Level of Learners' Performance in Terms of Written Test

Scores	Frequency	Percentage	Remarks
17-20	56	70.89%	Outstanding
13-16	21	26.58%	Very Satisfactory
9-12	3	3.80%	Satisfactory
5-8	0	0.00%	Fairly Satisfactory
0-4	0	0.00%	Did Not Meet Expectation
Total	79	100%	

Weighted Mean = 17.54
SD=2.32

Out of the 79 respondents, the majority (56 students or 70.89%) scored between 17-20, which falls under the Outstanding category.

This was followed by 21 students (26.58%) who scored between 13-16, classified as Very Satisfactory. Meanwhile, only 3 students (3.80%) attained scores between 9-12, categorized as Satisfactory. Notably, no students scored within the 5-8 and 0-4 ranges, meaning none were classified under Fairly Satisfactory or Did Not Meet Expectation The overall weighted mean score was 17.54, with a standard deviation of 2.32. These results imply that most students performed at an Outstanding level in the written test, indicating a strong understanding of mathematical concepts and problem-solving skills. Kusurkar et al. (2023) emphasized that assessment methods that foster autonomous motivation improve students' engagement and learning outcomes and performance.

Test of Significant Effect of Project-Based Integration Approach on Learners' Mathematical Learning Skills

Table 12 presents the results of multiple regression analyses examining the influence of the project-based integration approach on learners' mathematical learning skills across four dimensions: Problem-Solving Ability, Mathematical Reasoning, Numeracy Proficiency, and Mathematical Fluency.

For problem-solving ability, the regression model was not statistically significant, $F(5, 73) = 0.70$, $p = .622$, explaining only 4.6% of the variance ($R^2 = .046$). None of the predictor variables significantly contributed to problem-solving ability, as all p-values exceeded .05. The strongest, though still non-significant, predictor was curiosity and exploration ($B = -0.21$, $SE = 0.12$, $t = -1.73$, $p = .087$), implying a potential negative association that warrants further investigation.

For mathematical reasoning, the regression model was also not statistically significant, $F(5, 73) = 0.51$, $p = .765$, accounting for only 3.4% of the variance ($R^2 = .034$). No predictor variables significantly influenced mathematical reasoning, with p-values well above .05. The variable reflective process ($B = -0.16$, $SE = 0.14$, $t = -1.21$, $p = .231$) showed the strongest negative association, though not at a statistically significant level.

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TABLE 12. Summary of Regression Analysis for Learners' Mathematical Learning Skills from Project-Based Integration Approach

Problem-Solving Ability				
Predictor Variables	**B**	**SE B**	**t**	**p**
(Constant)	6.10	1.16	5.29	0.000
Curiosity and exploration	-0.21	0.12	-1.73	0.087
Interdisciplinary focus	0.03	0.14	0.18	0.855
Real world relevance	-0.03	0.13	-0.19	0.852
Reflective process	-0.07	0.13	-0.55	0.582
Assessment focus	-0.06	0.13	-0.44	0.662
Note. R^2 = .046, F(5, 73) = 0.70, p = .622. *p < .05, **p < .01, ***p < .001.				
Mathematical Reasoning				
Predictor Variables	**B**	**SE B**	**t**	**p**
(Constant)	5.60	1.25	4.49	0.000
Curiosity and exploration	-0.01	0.13	-0.09	0.927
Interdisciplinary focus	0.03	0.15	0.17	0.867
Real world relevance	-0.11	0.15	-0.78	0.438
Reflective process	-0.16	0.14	-1.21	0.231
Assessment focus	0.05	0.14	0.34	0.737
Note. R^2 = .034, F(5, 73) = 0.51, p = .765, *p < .05, **p < .01, ***p < .001.				
Numeracy Proficiency				
Predictor Variables	**B**	**SE B**	**t**	**p**
(Constant	5.71	0.91	6.26	0.000
Curiosity and exploration	0.01	0.10	0.13	0.899
Interdisciplinary focus	0.03	0.11	0.25	0.802
Real world relevance	-0.07	0.11	-0.63	0.532
Reflective process	-0.21	0.10	-2.10	0.039*
Assessment focus	0.04	0.11	0.34	0.734
Note. R^2 = .070, F(5, 73) = 1.11, p = .365, *p < .05, **p < .01, ***p < .001.				
Mathematical Fluency				
Predictor Variables	**B**	**SE B**	**t**	**p**
(Constant)	5.47	1.57	3.49	0.001
Curiosity and exploration	0.06	0.17	0.34	0.734
Interdisciplinary focus	0.00	0.19	-0.01	0.992
Real world relevance	-0.30	0.18	-1.62	0.109
Reflective process	0.09	0.17	0.55	0.584
Assessment focus	-0.02	0.18	-0.11	0.910
Note. R^2 = .040, F(5, 73) = 0.60, p = .697, *p < .05, **p < .01, ***p < .001.				

For numeracy proficiency, the regression model remained non-significant, F(5, 73) = 1.11, p = .365, but it explained a slightly higher portion of the variance (R^2 = .070). Among the predictor variables, reflective process (B = -0.21, SE = 0.10, t = -2.10, p = .039) was the only significant factor (p < .05), indicating that a greater emphasis on reflective processes was associated with lower numeracy proficiency. Other predictors did not have significant effects.

For mathematical fluency, the regression model was not statistically significant, F(5, 73) = 0.60, p = .697, accounting for only 4.0% of the variance (R^2 = .040). None of the predictor variables significantly influenced mathematical fluency, as all p-values exceeded .05. The strongest, though still non-significant, predictor was real-world relevance (B = -0.30, SE = 0.18, t = -1.62, p = .109), implying a potential negative effect.

Overall, this implies that the project-based integration approach, in its current form, does not significantly enhance learners' mathematical learning skills. However, the finding shows two key observations.

First, the negative effect of reflective process on the numeracy proficiency implying that emphasizing reflective learning might pose challenges in developing numeracy skills. Second, the marginally negative effect of curiosity and exploration on the problem-solving ability implies that exploratory activities may not always translate to improved problem-solving performance of the students.

Hoogland (2023) explained that numeracy skills are crucial for decision-making in a mathematically advanced society, but conventional teaching methods like inflexible algorithms and decontextualized number crunching reduce their value.

This implies that while project-based learning promotes engagement, its effectiveness in enhancing mathematical skills depends on its alignment with real-world applications. Similarly,

Zulkifli et al. (2022) proved that active engagement in education can be improved through techniques like idea mapping and peer teaching, suggesting that integrating structured collaboration within project-based learning may enhance its impact on mathematical proficiency.

Test of Significant Effect of Project-Based Integration Approach on Learners' Performance

To test the significant effect of project-based integration approach on learners' performance in mathematics in terms of practical and written test was treated statistically using Minitab v.16 using the regression analysis.

TABLE 13. Summary of Regression Analysis for Learners' Performance from Project-Based Integration Approach

Practical Test				
Predictor Variables	**B**	**SE B**	**t**	**p**
(Constant)	1.13	4.21	0.27	0.788
Curiosity and exploration	0.17	0.44	0.38	0.705
Interdisciplinary focus	0.73	0.50	1.46	0.150
Real world relevance	-0.39	0.49	-0.80	0.426
Reflective process	-0.45	0.46	-0.99	0.323
Assessment focus	0.58	0.49	1.20	0.235
Note. R^2 = .066, F(5, 73) = 1.04, p = .402. *p < .05, **p < .01, ***p < .001.				
Written Test				
Predictor Variables	**B**	**SE B**	**t**	**p**
(Constant)	-0.25	2.59	-0.10	0.924
Curiosity and exploration	0.32	0.27	1.16	0.251
Interdisciplinary focus	0.48	0.31	1.55	0.125
Real world relevance	0.02	0.30	0.06	0.949
Reflective process	-0.05	0.28	-0.19	0.848
Assessment focus	0.31	0.30	1.04	0.301
Note. R^2 = .075, F(5, 73) = 1.19, p = .323, *p < .05, **p < .01, ***p < .001.				

Table 13 presents the results of multiple regression analyses examining the effect of the project-based integration approach on learners' performance in both practical and written tests. The findings indicate that the project-based integration approach did not significantly predict learners' performance in either assessment type, as both regression models failed to reach statistical significance.

For the practical test, the regression model was not statistically significant, F(5, 73) = 1.04, p = .402, explaining only 6.6% of the variance (R^2 = .066). None of the predictor

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variables had a significant effect, with all p-values exceeding .05. The strongest, though still non-significant, positive predictor was interdisciplinary focus (B = 0.73, SE = 0.50, t = 1.46, p = .150), indicating a potential, albeit weak, positive association between interdisciplinary approaches and practical test performance. Conversely, reflective process (B = -0.45, SE = 0.46, t = -0.99, p = .323) showed the strongest negative effect, though it did not reach statistical significance.

Similarly, for the written test, the regression model was not statistically significant, F(5, 73) = 1.19, p = .323, explaining 7.5% of the variance (R^2 = .075). No predictor variable significantly affect written test performance, as all p-values were above .05. However, interdisciplinary focus (B = 0.48, SE = 0.31, t = 1.55, p = .125) emerged as the strongest, though still non-significant, positive predictor. On the other hand, reflective process (B = -0.05, SE = 0.28, t = -0.19, p = .848) had the weakest effect on written test scores.

Overall, this implies that the project-based integration approach did not have a statistically significant effect on learners' performance in either practical or written assessments. While interdisciplinary focus showed the strongest positive effect in both test types, the effects were not significant. Likewise, the reflective process appeared to have a weak or negative effect with performance, though these findings remain inconclusive.

Zhang (2023) noted that interdisciplinary approaches in mathematics education enhance students' ability to apply concepts across different subjects, potentially improving problem-solving skills. However, their direct influence on standardized assessments remains inconclusive. Similarly, Zulkifli et al. (2022) found that reflective learning strategies contribute to deeper mathematical understanding, yet their immediate impact on test performance is often minimal. These findings imply that while project-based learning fosters engagement and conceptual comprehension, its effect on learners' assessment outcomes may be moderated by other instructional and contextual factors.

IV. Conclusion and Recommendations

Based on the findings above, the following conclusions were hereby drawn:

Project-Based Integration Approach did not show a statistically significant impact on learners' mathematical learning skills. Two important observations emerged: the reflective process appeared to pose some challenges in developing numeracy proficiency, while curiosity and exploration showed limited connection to improved problem-solving skills. Therefore, the null hypothesis stating that the Project-Based Integration Approach has no significant effect on learners' mathematical learning skills is accepted.

Similarly, the approach did not significantly influence learners' performance in both practical and written assessments. Although the interdisciplinary focus showed the strongest relationship to test outcomes, its effect was not statistically confirmed. The role of reflection also appeared minimal, with no conclusive impact on overall performance. Therefore, the null hypothesis stating that the Project-Based Integration Approach has no significant effect on learners' performance is accepted.

In the formulated conclusions from the findings, it was recommended that:

Mathematics teachers may refine the implementation of project-based learning by incorporating structured problem-solving activities that directly reinforce mathematical skills and performance.

Learners may actively engage in project-based learning activities to enhance their problem-solving skills, mathematical reasoning, numeracy proficiency, and mathematical fluency.

Future researchers may explore additional factors influencing learners' mathematical learning skills and performance, such as instructional strategies, cognitive load, and student motivation, to further enhance the effectiveness of project-based learning.

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