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Project-Based Learning Approach in Developing the TVL Learners' Cognitive Skills and Performance

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Abstract*—The primary objective of this research is to investigate and analyze the relationship between the Project-Based Learning (PBL) Approach and the development of cognitive abilities and academic performance among Technical-Vocational-Livelihood (TVL) learners. This study aims to elucidate how PBL methodologies contribute to enhancing various cognitive skills, such as critical thinking, problem-solving, and memory retention, while simultaneously improving overall academic achievement in TVL education contexts. The study employs a descriptive, cross-sectional research design to examine the impact of Project-Based Learning (PBL) on TVL learners' cognitive abilities and performance. The research focuses on students in the Home Economics track at West Palale National High School during the 2024-2025 academic year. This approach allows for the investigation of relationships between PBL engagement and specific learning outcomes at a particular point in time, providing a snapshot of the educational impacts within the target population. The study reveals "Very High" results in teaching competencies across various aspects, indicating exceptional proficiency among educators. This suggests a well-rounded, highly effective teaching force likely to enhance student learning outcomes and adapt to new challenges. Similarly, Teacher's Achievement also score "Very High," implying outstanding performance and recognition in the profession. These results indicate highly effective educators who excel in their roles and positively impact student learning. The relationship between Professional Development, Teaching Competencies, and Teacher Achievement for TLE Teachers was found to be "Significant." This underscores the critical role of ongoing learning in educational success, suggesting that investing in professional development directly enhances teaching skills and leads to improved performance and recognition. The findings emphasize the importance of sustained, quality professional development programs in fostering a high-performing, competent, and recognized teaching workforce, ultimately benefiting student outcomes and overall educational quality. The study reveals the Project-Based Learning (PBL) significantly enhances student-centered, interdisciplinary, and collaborative learning. Results show high effectiveness in promoting active, self-directed learning and improving cognitive skills, particularly memory, attention, problem-solving, and critical thinking. PBL also boosts overall academic performance in both theoretical understanding and practical application. However, logical reasoning skills showed no significant improvement, indicating a potential limitation. These findings support broader implementation of PBL in various educational settings but suggest supplementing it with targeted activities for logical reasoning development. While the approach shows promise for comprehensive cognitive growth and improved student achievement, further research is needed to explore long-term effects and compare PBL with traditional teaching methods. Based on the conclusions, Project-Based Learning (PBL) significantly enhances student performance and cognitive abilities, particularly in memory, attention, problem-solving, and critical thinking. However, its impact on logical reasoning is limited. Assessment methods should be adapted to align with PBL's strengths, incorporating more performance-based tasks. Longitudinal studies are recommended to evaluate PBL's long-term impacts on academic and career outcomes. Future research should investigate PBL's limitations in logical reasoning and explore potential modifications to address this gap, ensuring a holistic approach to cognitive development in TVL learners.*

***Keywords*—** *Project-Based Learning (PBL), Cognitive abilities, Technical Vocational-Livelihood (TVL), Academic performance, Critical thinking.*

I. Introduction

In the swiftly progressing global landscape, education stands at the forefront of a transformative shift, seeking to fulfill the growing demands of the 21st-century economy and society. This era calls into question traditional pedagogical methods, prompting a crucial reevaluation in favor of approaches that cultivate both cognitive and technical competencies in students. As we navigate through this educational evolution, the focus sharpens on preparing a new generation of holistic learners who are adept in problem-solving and innovation and equipped with a suite of skills necessary for future success amid rapidly advancing technological landscapes.

Project-based learning (PBL) emerges as a vanguard in this transformative journey, championing a student-centric approach that emphasizes active learning through exploration and applied problem-solving. As a method crafted to push the boundaries of mere factual recall, PBL offers a conduit through intricate, hands-on projects, fostering meaningful collaboration and deep immersion into the learning material. This approach reflects the complexity of real-world challenges, inciting students to delve into subject intricacies while enhancing their technical capabilities.

This research focuses specifically on the application and relationship of Project-Based Learning among Senior High School students, particularly within the Technical-Vocational-Livelihood (TVL) - Home Economics (HE) strand. This segment represents a critical juncture in educational trajectories where PBL transcends the realm of instructional methodology to become an immersive experience that sparks intellectual curiosity, refines technical skill sets, and engenders a nuanced appreciation of academic content. Through this lens, PBL stands as an instrumental catalyst, nurturing well-rounded, agile minds poised to flourish within the knowledge-based economy.

Insightful empirical analysis, such as that presented by Kokotsaki et al. (2016), sheds light on the practical

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implications of PBL across the educational spectrum, offering a detailed portrait of its efficacy despite methodological limitations such as the absence of random participant assignments. Nonetheless, the analysis identifies key success factors of PBL, including the integration of digital resources, dynamic team collaborations, facilitative teaching, and balanced instructional approaches coupled with well-crafted assessments. This intricate mosaic of elements coalesces to unlock the full potential of PBL, fostering an educational environment that nurtures autonomy, investigative prowess, strategic goal setting, cooperative learning, effective dialogue, and reflective thinking—a setting that mirrors the complexity of real-life challenges.

As this research unfolds, it engages in a rigorous examination of Project-Based Learning's implications for cognitive and technical skill development among TVL- HE learners, acknowledging the challenges in establishing a definitive causal link between PBL and enhanced student performance while highlighting the approach's critical success factors. The aim is to conclude with strategic recommendations for PBL's sophisticated integration into mainstream education, underscored by the mission to equip young minds with the essential cognitive and technical skills required to navigate and contribute meaningfully to a dynamically interconnected world.

1.1 Statement of the Problem

This research aimed to determine the relationship of the Project- Based Learning Approach in Developing TVL Learners' Cognitive Abilities and Performance and sought to answer the following questions:

1. What is the level of the Project-Based Learning approach in terms of;
   - 1.1 Student-centered Learning;
   - 1.2 Interdisciplinary approaches; and
   - 1. 3 Collaborative Learning?
2. What is the level of the cognitive skills of the SHS Students in terms of;
   - 2.1 Memory attention;
   - 2.2 Problem-solving; and
   - 2.3 Critical thinking skills
   - 2.4 Logic and reasoning?
3. What is the level of the learners Performance in terms of;
   - 3.1 Written Test;
   - 3.2 Performance Task?
4. Is there a significant relationship between the project-based Learning approach and the cognitive skills of the Learners?
5. Is there a significant relationship between the Project-based Learning approach and the Learners Performance?

II. Methodology

The research design is descriptive and was employed to investigate the Project-Based Learning (PBL) approach in developing learners' cognitive abilities and performance in a cross-sectional research design. In this study, this research design is suitable for uncovering relationships between students' engagement in PBL and the development of specific learning outcomes at a certain point in time.

Using a cross-sectional approach, researchers to captured a snapshot of the educational landscape regarding PBL and its effectiveness. It involves collecting data about PBL practices, student cognitive abilities, and technical skills from a defined population of learners during a single period without the need to follow over an extended time frame. This design is beneficial for its efficiency and relative simplicity in terms of logistics and cost. These may include the extent and manner of PBL implementation, the level of student engagement in PBL activities, specific cognitive skills (such as critical thinking and problem-solving), and practical technical skills relevant to the curriculum, Sedgley et al. (2015).

III. Results and Discussion

This chapter deals with the presentation of the gathered data based on the research questions, the analysis, and interpretation relative to the sub-problem and hypothesis stated in the first chapter.

Level of Project-Based Learning Approach

In this study, the Project-Based Learning Approach was described in terms of student-centered learning, interdisciplinary approaches and collaborative learning and was determined by the mean and standard deviation.

The data in Table 1 reveals a remarkably high level of student participation in Project-Based Learning, particularly in Student-Centered Learning aspects (M=4.38, SD=0.61). This strong agreement indicates that students consistently employ inquiry-based approaches to explore questions and conduct research within projects. Moreover, they demonstrate effective collaboration with peers during project-based tasks, suggesting that PBL successfully fosters both independent inquiry skills and teamwork abilities. This high level of engagement underscores PBL's effectiveness in promoting active, student-driven learning experiences.

TABLE 1. *Level of Project-Based Learning Approach in terms of Student-Centered Learning*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
actively engages with the learning material through project-based learning activities.	4.40	0.67	Strongly Agree
take ownership of their learning by setting goals and reflecting on their progress.	4.23	0.59	Strongly Agree
effectively collaborate with peers during project-based learning tasks.	4.41	0.62	Strongly Agree
use critical thinking skills to solve problems presented in project-based learning activities.	4.39	0.60	Strongly Agree
regularly use inquiry-based approaches to explore questions and conduct research within projects.	4.45	0.56	Strongly Agree
Grand Mean	*4.38*		
SD	*0.61*		
Verbal Interpretation	*Very High*		

As presented in Table 2, the students show a very high level of project-based learning approach in terms of interdisciplinary approaches supported by the grand (M=4.33, SD=0.64); it was evident with the similar statement pertaining

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to statement number 1 and 2 that students engage in cross-disciplinary projects that combine insights and techniques from various fields.

Level of Project-Based Learning Approach in terms of Interdisciplinary Approaches

TABLE 2. *Level of Project-Based Learning Approach in terms of Interdisciplinary Approaches*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
perform projects that integrate knowledge and methods from different subjects or disciplines.	4.33	0.67	Strongly Agree
understand the concepts from one subject helped you solve a problem in another subject.	4.27	0.67	Strongly Agree
encounter challenges when trying to combine different areas of study in your project, especially in HE.	4.31	0.62	Strongly Agree
think that an interdisciplinary approach prepares you for real-world situations or careers.	4.34	0.64	Strongly Agree
discover connections between the subjects you are studying through this project.	4.41	0.61	Strongly Agree
Grand Mean	*4.33*		
SD	*0.64*		
Verbal Interpretation	*Very High*		

Recognize how ideas from one subject area can provide solutions to challenges in another, highlighting the interconnectedness of different disciplines. However, they have also discovered connections between the subjects that the teachers apply through the project based.

TABLE 3. *Level of Project-Based Learning Approach in terms of Collaborative Learning*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
collaborate with others helps them develop skills that are applicable outside the classroom.	4.31	0.68	Strongly Agree
learn from their peers that you might not have discovered working alone.	4.16	0.64	Agree
ensure that all group members are equally engaged and contributing to the project.	4.38	0.62	Strongly Agree
work with others enhances their understanding of the project or topic.	4.29	0.63	Strongly Agree
be responsible for individual and learning outcomes.	4.44	0.64	Strongly Agree
Grand Mean	*4.32*		
SD	*0.65*		
Verbal Interpretation	*Very High*		

Table 3 illustrates the extent to which project-based learning incorporates collaborative learning approaches, showcasing how students work together in project-based educational environments. It shows a very high level of project-based learning approach in terms of collaborative learning supported by the grand (M=4.32, SD=0.65), stating that the learners are responsible for individual and learning outcomes. In addition, learners abled to promote balanced participation and input from all team members throughout the project.

Level of Cognitive Skills

In this study, Cognitive Skills are described in terms of memory attention, problem solving, critical thinking and logic and reasoning and was determined by the mean and standard deviation.

TABLE 4. *Level of Cognitive Skills in terms of Memory Attention*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
pay close attention to details during learning activities	4.37	0.70	Strongly Agree
maintain focus and concentration for extended periods during tasks.	4.39	0.62	Strongly Agree
successfully manage to handle multiple tasks simultaneously without losing focus.	4.44	0.66	Strongly Agree
use working memory to hold and manipulate information during problem-solving tasks.	4.31	0.71	Strongly Agree
shift attention from one activity to another smoothly and without confusion.	4.34	0.66	Strongly Agree
Grand Mean	*4.37*		
SD	*0.67*		
Verbal Interpretation	*Very High*		

Table 4 presents data on the level of cognitive skills, specifically focusing on memory and attention capabilities among participants. It shows a very high level of Cognitive Skills in terms of Memory Attention with the grand (M=4.37, SD=0.67). It is evident that the learners Successfully manage to handle multiple tasks simultaneously without losing focus. Maintain focus and concentration for extended periods during tasks. Same with statement number 2 stating that the learners were able to pay close attention to details during learning activities that help them succeed in the memory attention for shifting activity to one another.

Level of Cognitive Skills in terms of Problem-Solving Skills

Table 5 presents data on the level of cognitive skills, specifically focusing on problem-solving abilities among participants. This table illustrates a very high level of Cognitive Skills in terms problem-solving skills with the grand (M=4.31, SD=0.66). With these various aspects of problem-solving competencies, it was evident that the learners were able to manage their proficient in implementing the chosen solution effectively, similar with the effective collaboration with others to solve the problem. They have also to practice and analyze information to understand the root cause of the problem to find a solution to it.

TABLE 5. *Level of Cognitive Skills in terms of Problem-Solving Skills*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
be proficient in implementing the chosen solution effectively.	4.35	0.61	Strongly Agree
use critical thinking skills to approach and solve different types of problems.	4.33	0.66	Strongly Agree
successfully collaborate with others to solve problems.	4.35	0.66	Strongly Agree
effectively ignore irrelevant information and focus on the task at hand.	4.20	0.67	Agree
effectively analyze information to understand the root cause of a problem.	4.32	0.70	Strongly Agree
Grand Mean	*4.31*		
SD	*0.66*		
Verbal Interpretation	*Very High*		

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Table 6 examines the level of cognitive skills with a specific focus on critical thinking abilities. It shows a very high level of cognitive skills in terms of critical thinking skills, supported by the grant (M=4.32, SD=0.53), stating that the learners reflect on their learning experiences and make improvements based on feedback and self-assessment.

TABLE 6. *Level of Cognitive Skills in terms of Critical Thinking*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
analyze and evaluate information critically when working on project-based tasks.	4.34	0.67	Strongly Agree
apply problem-solving strategies to overcome challenges encountered in project implementation	4.21	0.65	Strongly Agree
demonstrate logical reasoning and decision-making in selecting appropriate materials, techniques, or solutions.	4.33	0.57	Strongly Agree
synthesize different sources of information to create meaningful and innovative outputs.	4.33	0.62	Strongly Agree
reflect on their learning experiences and make improvements based on feedback and self-assessment.	4.40	0.61	Strongly Agree
Grand Mean		*4.32*	
SD		*0.53*	
Verbal Interpretation		*Very High*	

They are also able to analyze and evaluate information critically when working on project-based tasks, like statements number 3 and 4, that exhibit proficiency in logical reasoning and decision-making processes, particularly when choosing suitable resources, methods, or resolutions. Skillfully integrate diverse information sources to produce valuable and original outcomes.

TABLE 7. *Level of Cognitive Skills in terms of Logic and Reasoning*

STATEMENT	Mean	SD	Remarks
The Learners were able to…			
apply critical thinking to evaluate arguments and propositions.	4.28	0.66	Strongly Agree
analyze situations methodically to break down complex problems.	4.34	0.66	Strongly Agree
use inductive reasoning effectively by forming generalizations based on specific observations.	4.25	0.66	Strongly Agree
construct coherent and logical arguments.	4.15	0.71	Agree
reflect on their reasoning process and seeks to improve.	4.29	0.66	Strongly Agree
Grand Mean		*4.26*	
SD		*0.67*	
Verbal Interpretation		*Very High*	

Table 7 presents data on the level of cognitive skills, specifically focusing on logic and reasoning abilities. This table illustrates very high level of cognitive skills in terms of logic and reasoning abilities, supported by the grant (M=4.26, SD=0.67), stating the various aspects of logical thinking and reasoning competencies among the study participants. The learners analyze situations methodically to break down complex problems as they come up for the proper reasoning. However, the learners develop well-structured and rational lines of reasoning providing insights into their analytical capabilities.

Level of Learners' Performance

In this study, learners' performance was described in terms of written test and performance task and was determined by frequency, percentage, mean score and standard deviation.

TABLE 8. *Level of Learners' Performance in terms of Written Test*

Score	Frequency	Percentage	Descriptive Value
41 – 50	0	0%	Excellent
31 – 40	82	86%	Proficient
21 – 30	13	14%	Satisfactory
11 – 20			Needs Improvement
10			Poor
Mean Score		***33.66***	
SD		***2.49***	
Descriptive Value		***Proficient***	

Table 8 presents the distribution of learners' performance in a written test, categorizing scores into five ranges. Most learners (86%) scored in the "Proficient" range (31-40 points), while a smaller portion (14%) achieved "Satisfactory" scores (21-30 points). Notably, no learners scored in the "Excellent" range (41-50 points), nor were there any scores recorded in the "Needs Improvement" (11-20) or "Poor" (1-10) ranges. The mean score of 33.66 falls within the "Proficient" category, indicating that on average, learners demonstrated a strong performance. The standard deviation of 2.49 suggests relatively low variability in scores, meaning most learners performed consistently well.

TABLE 9. *Level of Learners' Performance in terms of Performance Task*

Performance Task	Mean Score	SD	Descriptive Value
Practical	40.57	3.97	Excellent
Grand Mean Score		***37.12***	
SD		***3.23***	
Descriptive Value		***Proficient***	

Table 9 reveals a notable comparison between learners' performance in practical and written tasks. The table provides insightful information about the learners' abilities and the nature of the assessment methods employed.

In practical tasks, learners demonstrated excellent performance with a mean score of 40.57 and a standard deviation of 3.97. This indicates a high level of hands-on skills and effective application of knowledge. The overall performance, represented by the grand mean score of 37.12 and a standard deviation of 3.23, falls in the proficient range.

Significant Relationship of Project-Based Learning Approach to the Cognitive Skills of Learners

To test the relationship of Project-Based Learning Approach to the cognitive skills of learners, data were treated statistically in Minitab 14 using Pearsons R. The major findings were presented in the following table.

Presented in table 10 is the Relationship of Project-Based Learning Approach to the cognitive skills of learners. The results include Pearson correlation coefficients (r-values), p-values, and sample size (N=95) for each relationship.

The results show a significant positive relationship of Project-Based Learning Approach in terms of student-centered learning, interdisciplinary approach and collaborative learning to learners' cognitive skills in terms of memory attention,

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problem-solving and critical thinking which showcase the importance of the Project-Based Learning approach enhance the cognitive skills of learners. This indicates further with the implementation of PBL approach students tend to show improved focus and memory retention, analyze problems more effectively, can think critically. However, Project-Based Learning Approach *does not have a significant relationship* to learners' cognitive skills in terms logic and reasoning which means that PBL fosters memory, problem-solving, and critical thinking, it may not directly improve logical reasoning skills. To conclude, while PBL enhances key cognitive skills, additional instructional strategies may be required to develop students logical and reasoning abilities.

TABLE 10. *Significant Relationship of Project-Based Learning Approach to the Cognitive Skills of Learners*

Project-Based Learning Approach (IV)	**Cognitive Skills of Learners (DV)**			
	Memory Attention	Problem Solving	Critical Thinking	Logic and Reasoning
Student-Centered Learning:				
Pearson Correlation	0.357	0.347	0.333	0.030
p-value	0.000*	0.001*	0.001*	0.776
N	95	95	95	95
Interdisciplinary Approaches:				
Pearson Correlation	0.338	0.338	0.372	0.048
p-value	0.001*	0.001*	0.000*	0.644
N	95	95	95	95
Collaborative Learning:				
Pearson Correlation	0.300	0.359	0.291	0.052
p-value	0.003*	0.000*	0.004*	0.615
N	95	95	95	84

*Note: * p < .05*

Table 10 reveals significant positive relationships between Project-Based Learning (PBL) approaches and learners' cognitive skills in memory attention, problem-solving, and critical thinking. This suggests PBL effectively enhances these abilities through student-centered, interdisciplinary, and collaborative learning. However, no significant relationship was found with logic and reasoning skills, indicating PBL may not sufficiently develop these areas. The findings imply PBL contributes to holistic cognitive development but may require supplementary strategies for comprehensive skill enhancement, particularly in logical reasoning. Educators can use PBL strategically to target specific cognitive abilities. With a sample size of 95, the results provide a reliable foundation for these implications.

Significant Relationship of Project-Based Learning Approach to the Learners' Performance

To test the significant relationship of Project-Based Learning Approach to the learners' performance data were treated statistically in Minitab 14 using Pearsons R. The major findings were presented in the following table.

Table 11 shows the result in the Significant Relationship of Project-Based Learning Approach to the Learners' Performance. The results include Pearson correlation coefficients (r-values), p-values, and sample size (N=95) for each relationship.

The results show a significant positive relationship of Project-Based Learning Approach in terms of student-centered learning, interdisciplinary approach and collaborative learning to learners' cognitive skills in terms of memory attention, problem-solving and critical thinking which showcase the importance of the Project-Based Learning approach enhance the cognitive skills of learners. This indicates further with the implementation of PBL approach students tend to show improved focus and memory retention, analyze problems more effectively, can think critically. Similar with the previous table result, Project-Based Learning Approach does not have a significant relationship to learners' cognitive skills in terms logic and reasoning which means that PBL fosters memory, problem-solving, and critical thinking, it may not directly improve logical reasoning skills. To conclude, while PBL enhances key cognitive skills, additional instructional strategies may be required to develop students logical and reasoning abilities.

TABLE 11. *Significant Relationship of Project-Based Learning Approach to the Learners' Performance*

Project-Based Learning Approach (IV)	**Learners' Performance (DV)**	
	Written Test	Performance Task
Student-Centered Learning:		
Pearson Correlation	0.078	0.031
p-value	0.455	0.769
N	95	95
Interdisciplinary Approaches:		
Pearson Correlation	0.078	0.055
p-value	0.455	0.593
N	95	95
Collaborative Learning:		
Pearson Correlation	0.272	0.234
p-value	0.008*	0.022*
N	95	95

*Note: * p < .05*

The results in Table 11 imply that Project-Based Learning (PBL) has a significant positive relationship with learners' cognitive skills in memory attention, problem-solving, and critical thinking. This suggests that implementing PBL approaches can enhance these specific cognitive abilities in students. However, PBL shows no significant relationship with logic and reasoning skills, indicating that it may not directly improve these abilities. The findings imply that while PBL is effective for developing certain cognitive skills, additional instructional strategies may be necessary to fully develop students' logical reasoning abilities. Educators can use PBL strategically to target specific cognitive skills but should

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consider complementary methods for comprehensive cognitive development.

IV. Conclusion and Recommendations

Based on the comprehensive analysis of the relationship Project- Based Learning Approach in Developing TVL Learners' Cognitive Abilities and Performance, the following conclusions:

1. The study reveals Project-Based Learning's positive on student performance, enhancing various cognitive skills except logical reasoning. This implies educators should implement PBL while supplementing it with strategies targeting logical reasoning. The null hypothesis stating the project-based Learning approach has no significant relationship in the SHS learner's Cognitive skills, therefore the null hypothesis is accepted.
2. The results show a significant positive relationship between the Project-Based Learning Approach to the learner's Performance in terms of student-centered Learning, interdisciplinary approach, and collaborative Learning to learners' cognitive skills in terms of memory attention, problem-solving, and critical thinking. Null hypothesis stating the Project-based Learning approach has no significant relationship with the SHS Learners' Performance, therefore the null hypotheis is rejected.

Based on the conclusions provided, here are comprehensive recommendations,

1. For School Administrators and Curriculum Developers. Implement Project-Based Learning widely across curricula to enhance student performance and cognitive skills.
2. For Teachers. Supplement PBL with targeted activities to improve logical reasoning skills.
3. For Professional Development Facilitators. Provide comprehensive teacher training on effective PBL implementation and supplementary techniques.

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