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Optimizing Problem-Based and Project -Based Learning in Technology and Livelihood Education in Improving Student Engagement and Technical Competence

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A B S T R A C T

This study addresses the optimization of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) methodologies for further maximizing the student engagement and technical abilities in learning environments. The study compares these two active learning styles based on their capacity to facilitate technical consciousness, improve critical thinking, and promote group working competence among the learners. The quasi-experimental research design is employed to test the interaction of independent variable which is project-based learning and problem-based learning and dependent variables which are student engagement and the technical competence. The respondents of the research are 70 Grade 8 students of two sections that are selected by means of match pairing in San Vicente Integrated High School. Two lesson plans, one for PBL and one for PjBL, were created and pilot-tested for implementation. Group A was taught using the PBL method, and Group B used the PjBL technique. Both groups took a posttest, and reflective exercises followed each presentation. A questionnaire survey on the use of both methodologies was also carried out to provide student feedback. Statistical analysis was done on results to identify how effective each of the learning approaches was. Results show that both PBL and PjBL, when appropriately implemented, produce better motivation, participation, and retention of technical knowledge among students. The study shows that the refinement of PBL-PjBL integration in curriculum development can be an efficient method for enhancing technical competency as well as overall learning process of students. Educators are suggested to develop explicit instructional frameworks, collaborative learning environments, and constant assessment strategies to bring maximum efficiency in these pedagogical practices.

Keywords: problem-based learning, project-based learning, technical competence, student engagement, agentic engagement

1. Introduction

In the rapidly evolving global economy of today, education systems globally are faced with the need to transition from conventional, rote-learning instruction to instructional methods that cultivate learners' critical thinking, problem-solving, and technical competencies. The demand for active, authentic, and skills-oriented education has necessitated the incorporation of Problem-Based Learning (PBL) and Project-Based Learning (PjBL) into subjects across international curricula (McPherson and Heggie, 2015). These methods work particularly well in technical-vocational education, where students are not only expected to learn concepts but also use them in authentic situations (Harris T.,2022).

The problem-based learning is an instructional method that focuses on engaging students in the process of solving real-word problems. Instead of traditional instruction where teachers provide information and students passively receive it, PBL places students in active roles where they must identify what they need to learn in order to solve a given problem. On the other hand, project-based learning is an instructional method where students learn by actively engaging in real-world and meaningful projects. PjBL requires students to explore, investigate, and solve problems culminating in a final product.

Student engagement is one of the important constructs that is used to understand the behavior of the student towards the teaching-learning process. Understanding the behavior of students in the academic institutions will provide a glimpse of how the instructions and academic practices are going on in the university. As such, it could be used as a powerful tool by the teachers and academic supervisors to design an effective pedagogical technique to maximize the learning experiences of the students.

TLE aims to equip students with practical skills that are directly applicable to various trades and professions. Students who possess technical competence are guaranteed to be able to use tools and technologies related to their field and complete tasks efficiently. Possessing technical skills is essential for landing a job in many industries. To create competent people who can effectively contribute to their professions, spur innovation, promote economic growth, and adjust to the rapidly evolving technological landscape, technical competence in TLE is essential.

In the Philippines, a 2023 UNICEF report, outlines some of the reasons why some students do not go to school (Chi, 2023). Lack of personal interest is the main excuse given by high school pupils for not attending class. One of the obstacles educators, especially those who work with secondary school students, must overcome is getting kids interested in learning. For many teenagers, this is also a time when they are unsure of their ability to excel in academic pursuits, questioning the purpose and value of homework, which leads to a decrease in academic effort. For this reason, the social atmosphere in the classroom, which includes perceived instructor support as well as perceived peer support, is vital (Francisco, et.al, 2015).

Hence, the need to address the growing disengagement of learners which affect their performance in the classroom using innovative strategies such as problem-based learning and project-based learning.

Problem- based learning is anchored on the constructivism theory which emphasizes that learners actively construct their own understanding and knowledge of the world, through experiencing things and reflecting and reflecting on those experiences (Savery, J. R. 2015). It also draws from Vygotsky's social-constructivism theory, which highlights the importance of social interaction and teamwork in the creation of knowledge. In order to reflect the social nature of learning, PBL usually entails group projects in which students cooperatively investigate issues, exchange viewpoints, and create knowledge (Hmelo-Silver, C.E & Barrows, H.S., 2015). A number of educational theories that place a strong emphasis on active learning, critical thinking, and the social construction of knowledge are the foundation of problem-based learning.

The project-based learning is also anchored on the constructivism theory, rooted in the work of Piaget and Vygostky, learners actively construct their own understanding. In PjBL students construct knowledge by engaging in hands-on projects that require critical thinking, problem- solving and application of concepts (Savery, J.K., 2015).

PjBL is closely related to inquiry -based learning as it involves students in exploring questions, investigating problems and discovering solutions through project work (Kuh Ithau, C.C., et al., 2019). These theories provide the foundation for PjBL's focus on student centered projects, real- world application, and collaborative learning environments.

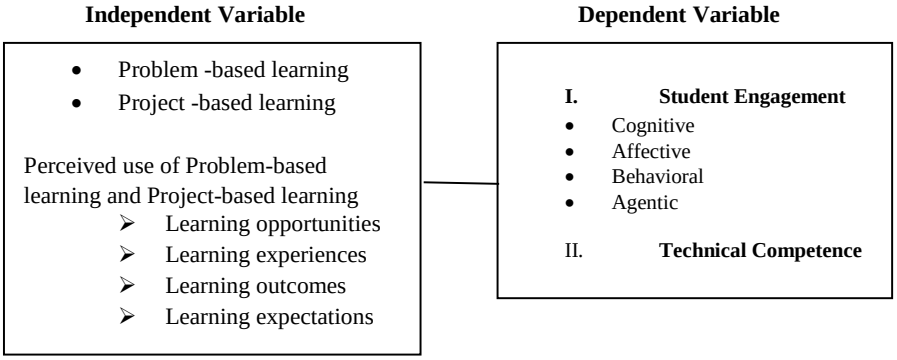

Figure 1: Research Framework

2. Research Problem

Specifically, this study aimed to answer the following questions:

1. What are the respondents' profile in terms of:

1.1. age;

1.2. sex;

1.3. Academic achievement/ quarterly grade?

2. What is the perception of the respondents on the use of problem-based learning and project-based learning in terms of :

2.1. Learning opportunities;

2.2. Learning experiences;

2.3. Learning outcomes; and

2.4. Learning expectations?

3. What is the participants' level of engagement before and after the use of problem-based learning and project-based learning in terms of:

3.1. Cognitive;

3.2. Affective;

3.3. Behavioral; and

3.4. Agentic?

4. What is the participants level of technical competence before and after the use of problem-based learning and project -based learning?

5. Do the levels of engagement of the problem-based learning group differ significantly to those of the project-based learning?

6. Is there a significant difference in the levels of engagement within the problem-based learning and project-based learning group before and after the use of problem-based learning and project-based learning?

7. Do the scores in the technical competence of the two learning groups differ significantly before and after the use of problem-based learning and project-based learning?

8. Is there a significant difference in the pre and post test scores within the problem-based and project-based groups?

3. Materials and Methods

Quasi- experimental research design is a research method used to investigate the interaction between independent variables which are problem-based learning and project -based learning and dependent variables which are the student engagement and the technical competence, which is used to determine a cause-and-effect relationship.

The respondents are 70 Grade 8 students from two diverse sections in San Vicente Integrated High School, that are chosen through match pairing or match sampling. This method involved matching or pairing subjects in two or more groups based on specific characteristics to ensure that these groups are comparable at the start of the study. In this study, two heterogenous sections are matched based on their first quarter TLE grade. By doing so, it is possible to argue that there will be a difference in their technical competence and engagement by using problem-based and project -based learning. In the selection of the Grade 8 students from San Vicente Integrated High School, the researcher used match pairing that served as the respondents of the study.

Two sets of lesson plans were used based on the Nail Care Services exploratory competencies. One will be using the problem-based learning approach, and the other one is the project-based learning. The research instruments have undergone both external and internal validation. The researcher asked permission from the principal of San Vicente Integrated High School and the Division office of San Pablo City to conduct the study during the Second quarter of the school year 2024-2025. The grade 8 students chosen are subjected to the study after the approval. The basis for the matched- pairing of students are their first quarter grade.

The teacher made lesson plans are executed. Problem-based learning approach will be applied to group A and project-based learning are executed to group B. Students answered the post-test prepared by the researcher.

To conduct problem-based learning, a set of problems are presented to class related to the topic. Students are divided into small groups, allowing them to collaborate and share ideas. Before the students solve the problem, set clear objectives. Problems are presented in a scenario. Students are encouraged to gather information based on the problem assigned to them. After conducting research, each group proposed solutions and lastly have each group present their solutions. In conducting project-based learning, it started by giving the students an overview of the project and setting the objectives. The teacher guided the students as they develop their project. The role of the teacher is to facilitate learning process by providing feedback and encourage problem-solving if students encounter difficulties with the project. Once the project is complete, each group should present their final product to the class. After the presentation of both problem-based and project-based output, reflection is encouraged by asking questions related to the topic. Teacher provided constructive feedback on their work.

This study used different instruments to gather data that are needed to answer the research problems. Pre-test and post-test assessment and lesson plans are also included. For the 50-item pre-test and post-test assessment, table of specification are prepared based on the learning competencies in Nail Care services. The researcher used a Likert-scale questionnaire to determine the respondents' perception on the use of Problem-based learning and Project-based learning. The instruments used have undergone external validation.

The data gathered were submitted to several statistical measurements and methods to assist the researcher in presenting, analyzing and interpreting the data that were collected. The scores of the respondents that completed the evaluation tools are determined using the frequency count. Mean Gain scores are used to determine the difference between respondents' test scores on the pre-test and post-test.A paired T-test is used to see if there is a significant difference between the pre-test and post-test scores of the two groups after being exposed to problem-based learning and project-based learning.On the other hand, an independent t-test is utilized to determine if there is a significant difference between the mean post-test scores of the two groups of students.

4. Result and Discussions

As shown in Table 1, by the age factor, the number of students attending PBL or PjBL are heterogeneous population of students across a range of ages. From the data, most of the students in both groups are 13 and 14 years old. More PBL students, that is, 42.9%, were 13 years old compared to 51.4% of PjBL students. Although the PBL group also has a relatively high rate at 14 years of age, with 37.1%, it is slightly less than that for the PjBL group where 40% of the students are 14. Only 17.1% of 15-year-olds in PBL. Even fewer, 2.9%, are 16-year-olds. PjBL shows a slight, but noticeably higher at the age of 15, and 8.6% on the age of 16. The table also shows the gender of students involved in Problem-Based Learning and Project-Based Learning of the heterogenous sections. Results have shown that males dominate a bit more in both methods of learning and they are 57.1% and 54.3% from PBL and

PjBL respectively. The feminine gender composed 42.9% in the PBL group and 45.7% in the PjBL. While males have a marginally higher rate in both methods, the difference between male and female representation is relatively small, which indicates that both genders are similarly engaged in these types of learning environments.

The table also shows the students' achievement before being exposed to Problem-Based Learning and Project-Based Learning based on students' quarterly grades. PjBL participants reflect a higher proportion of students having a grade score of 90 and above. It is in fact, 37.1%, while that for PBL is only 25.7%. The percentage of students in both learning models with grades within the range of 75-79 is also the same, at 40%. Students' beliefs about the learning opportunities offered through Nail Care services by applying the Problem-Based Learning (PBL) and Project-Based Learning (PjBL) strategies are compared in Table 2. The two educational philosophies are assessed by utilizing five indicators of the fundamental building blocks of vocational education, whose Likert scale outcomes range from Strongly Disagree to Strongly Agree.

Overall, students "Agreed" that PBL and PjBL are both great learning experiences (mean = 3.25 and 3.31, respectively). Interestingly, Project-Based Learning had slightly higher overall mean scores, reflecting a moderate student preference for learning through projects, which typically entail practical exercises and real-world applications.

Table 1: Distribution on the Respondents' Profile by Age, Sex and Academic Achievement

	Problem-Based		Project-Based	
	Frequency	Percentage	Frequency	Percentage
Age Profile				
13	15	42.9	18	51.4
14	13	37.1	14	40
15	6	17.1	-	-
16	1	2.9	3	8.6
TOTAL	35	100	35	100
Sex				
Male	20	57.1	19	54.3
Female	15	42.9	16	45.7
TOTAL	35	100	35	100
Academic Achievement				
90 and above	9	25.7	13	37.1
85-89	6	17.1	5	14.3
80-84	6	17.1	3	8.6
75-79	14	40	14	40
Below 75	-	-	-	-
TOTAL	35	100	35	100

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In viewing the ratings of the individual indicators, PjBL was rated "Strongly Agree" (mean = 3.60) on its capacity to deploy theoretical knowledge to real-life situations, again testifying to the strength of PjBL in linking classroom learning to actual Nail Care practices. This is in line with a 2019 Thomas and Thorne study that highlighted PjBL's potential to enhance vocational learners' capacity to convert ideas into concrete outcomes, particularly in cosmetology classes. Conversely, even though PBL ranked highly (mean = 3.34) in this category, its lower ranking implies that, as valuable as it is, it may not be as engaging in actual scenarios as PjBL. Students in Nail Care services under the critical thinking front, PBL (mean = 3.40) and PjBL (mean

= 3.34), were presumed to be equally successful. The advantage of PBL is supported by research by Belland et al. (2017), who asserted that PBL learning environments promote more analysis and reflective thinking by necessitating students to solve challenging, often ill-defined problems.

PjBL (mean = 3.40) was believed to promote teamwork better than PBL (mean = 3.00). This is likely since PjBL projects are collaborative and often take the form of salon environments that require teamwork. Based on Wurdinger and Qureshi's (2016) study, PjBL significantly enhances interpersonal, communication, and teamwork skills.

Table 2. Perception of the Respondents as to Learning Opportunities

Indicator	Problem-Based			Project-Based		
	Mean	SD	VI	Mean	SD	VI
Problem/Project -Based Learning ……						
1. provides opportunities formed to apply theoretical knowledge to practical situations	3.34	0.64	Agree	3.60	0.55	Strongly Agree
2. encourages me to develop critical thinking skills	3.40	0.74	Agree	3.34	0.68	Agree
3. offers opportunities to collaborate with peers and work in teams	3.00	0.84	Agree	3.40	0.60	Agree
4. increases my engagement and motivation to learn.	3.06	0.87	Agree	3.20	0.72	Agree
5. promotes self-directed learning and independent research	3.43	0.61	Agree	3.03	0.75	Agree
Over-all	3.25	0.47	Agree	3.31	0.48	Agree

Legend: *3.50-4.00 (Strongly Agree), 2.50-3.49 (Agree), 1.50-2.49 (Disagree), 1.00-1.49 (Strongly disagree)*

As for motivation and participation, PjBL still boasted a slightly higher mean value (3.20) than PBL (3.06), although both are still under the "Agree" zone. As cited in Banfield and Wilkerson (2018), project-based students commonly indicate higher levels of motivation owing to ownership and work relevance of activities to practical settings. This contrasts with PBL, where at times, it can feel theoretical or academically biased unless properly grounded.

PBL rated higher (3.43) in self-directed learning compared to PjBL (3.03), and this indicates that problem-based learning could prompt the students to dig deeper than what is provided for them, engage in independent studies, and act as self-starter learners searching for solutions. Hmelo-Silver (2017) confirms this through the observation that PBL situates the learners as active knowledge constructors, something that promotes autonomy and lifelong learning processes.

In conclusion, the evidence indicates that Project-Based Learning is more suitable for the development of practical skills, collaboration, and student motivation, whereas Problem-Based Learning is more effective in developing critical thinking and independent learning.The researcher concluded that both Problem-Based Learning (PBL) and Project-Based Learning (PjBL) are effective in providing valuable learning opportunities for students, but PjBL is generally perceived to be more advantageous in fostering specific learning outcomes. The positive responses from students across both teaching methods indicate that these student-centered approaches are well received and perceived to enhance the application of theoretical knowledge to real-world scenarios. Specifically, PjBL demonstrated a stronger perceived connection between theory and practice, since there is a tangible product like making the structure of the nail that is the outcome of their lesson.

Table 3. Perception of the Respondents as to Learning Experiences

Indicator	**Problem-Based**			**Project-Based**		
	Mean	SD	VI	Mean	SD	VI
Problem/Project-based Learning …….						
1. keeps me engaged and interested in the subject matter	3.31	0.72	Agree	3.43	0.56	Agree

2.	**helps me understand and retain the lesson content better than traditional lectures.**	3.57	0.65	Strongly agree	3.29	0.71	Agree
3.	**allows me to apply theoretical concepts to practical situations**	2.86	0.60	Agree	3.00	0.73	Agree
4.	**provides various ways through which I acquire knowledge, skills ang attitudes.**	3.26	0.66	Agree	3.20	0.63	Agree
5.	**allows me to apply theoretical concepts to practical situations**	2.97	0.82	Agree	3.17	0.79	Agree
Over-all		3.19	0.39	Agree	3.22	0.42	Agree

Legend: *3.50-4.00 (Strongly Agree), 2.50-3.49 (Agree), 1.50-2.49 (Disagree), 1.00-1.49 (Strongly disagree)*

The information in Table 3 shows the perceptions of the learners' experience from Problem-Based Learning (PBL) and Project-Based Learning (PjBL) in Nail Care services. Both the methodologies were given a general qualitative response of "Agree" from the overall mean of 3.19 for PBL and 3.22, just a little more. This implies that the learners perceive both methods as positive for defining their learning experience but neither of them predominantly surpassed expectations.

Considering individual indicators, PjBL (mean = 3.43) was seen to be slightly more effective than PBL (mean = 3.31) in maintaining students' interest and engagement with the subject matter. This supports the research of Wurdinger and Qureshi (2016), which highlighted that project-based learning environments provide contextual, meaningful learning, enhancing student motivation and emotional involvement. Such activities usually mimic salon or spa-based tasks, i.e., client consultations, design of nail art, and preparing for service, which are possibly more engaging to students.

In addition, PBL outperformed PjBL through this exercise, obtaining a "Strongly Agree" value (mean = 3.57) in terms of aiding learners' understanding and recall of instructions better than typical teaching methods. This would indeed support Hmelo-Silver's (2017) conclusion of students achieving higher level conceptual learning through problem-based learning by using guided inquiry and problem-solving. In Nail Care, for example, live customer care scenarios or hygiene-related problems could be used, leading to critical thinking and retention of preferred learning retention. With reference to transferring theoretical concepts into practical applications, PBL (2.86) and PjBL (3.00) were in the "Agree" zone but slightly higher in PjBL. This further supports previous research, including Thomas & Thorne (2019), where practical strength for vocational training models like project-based ones was proven again. In Nail Care, the students have advantages working with real cases or practicing with simulation of client circumstances whereby they could switch from what was taught in the classroom into application in action.

In the aspect of offering diverse learning opportunities—knowledge, skills, and attitudes—both methodologies were similarly rated (PBL = 3.26, PjBL = 3.20), implying that both methodologies are considered to be multidimensional in offering holistic learning experiences. Such results corroborate Belland et al. (2017), which explained that PBL and PjBL both address various learning styles, which is significant in areas where both technical skills and social skills are needed.

Lastly, it should be mentioned that one of the indicators—"allows me to apply theoretical concepts to practical situations"—is referred to twice (Items 3 and 5). Both reproduce consistent outcomes, with PBL (2.86 and 2.97) ever so slightly less than PjBL (3.00 and 3.17), again suggestive of the comparative effectiveness of PjBL as a facilitator of real-world application.

Table 4. Perception of the Respondents as to Learning Outcomes

Indicator	Problem-Based			Project-Based		
	Mean	SD	VI	Mean	SD	VI
Problem/Project -based learning……						
1. has contributed to the development of my practical skills.	3.37	0.69	Agree	3.43	0.74	Agree
2. has enabled me to apply the knowledge I gained to real-world scenarios.	3.29	0.75	Agree	3.17	0.75	Agree

3.	has improved my communication skills, particularly in articulating complex ideas.	3.34	0.73	Agree	3.46	0.56	Agree
4.	has enhanced my ability to work effectively in a team.	3.20	0.76	Agree	3.31	0.72	Agree
5.	has sharpened my analytical skills.	3.11	0.83	Agree	3.29	0.67	Agree
Over-all		3.26	0.51	Agree	3.33	0.47	Agree

Legend: *3.50-4.00 (Strongly Agree), 2.50-3.49 (Agree), 1.50-2.49 (Disagree), 1.00-1.49 (Strongly disagree)*

Table 4 presents the students' assessment of the learning outcomes they obtained through the two learning methods of project-based learning (PjBL) and problem-based learning (PBL) with Nail Care services. Both methods got positive ratings, with a mean score of 3.26 for PBL and 3.33 for PjBL. This indicates that although PjBL is a bit higher on most of the parameters, individuals believe that both methods work well in producing applicable learning outcomes. When it comes to the acquisition of practical skills, PjBL (mean = 3.43) performs slightly better than PBL (mean = 3.37). This result is consistent with previous studies, e.g., those of Thomas and Thorne (2019), who concluded that project-based learning is best at developing technical skills in cosmetology and other service training. This is because nail care is a practical professional field. By involving students in hands-on projects, e.g., exhibits of nail art or practice salon services, PjBL provides a simple process for skill development.

In the application of knowledge to practical situations, the two learning models were rated equally (PBL = 3.29; PjBL = 3.17), although a bit higher for PBL. This suggests that problem-solving of client issues or hygiene and safety issues within a PBL setting can aid learners in the translation of theoretical knowledge into practice. Like how the students solve the complaints about unclean Nail care tools and unsafe working conditions in a workplace. This corroborates Hmelo-Silver's (2017) statement that problem-based settings aid learners in internalizing and reconstructing knowledge to different, practical situations.

Communication skills, particularly in the exposition of complex ideas, are essential in client-based professions like Nail Care. Here, PjBL had the highest mean score in the table (3.46), only slightly higher than PBL (3.34). This finding is in line with Wurdinger and Qureshi (2016), who explained that project-based learning fosters better interpersonal communication and presentation skills since it establishes an emphasis on collaboration and public presentations of knowledge.

As for collaboration, both methods were well-rated, but again, PjBL (3.31) surpassed PBL (3.20). Project-based tasks usually require students to work together, assign responsibilities, and share outcomes—serious factors in the development of teamwork skills. Such findings are in agreement with Belland et al.'s (2017) finding that PjBL allows social and teamwork skills through cooperative learning tasks. Lastly, about honing analytical skills, both methodologies were considered effective (PBL = 3.11; PjBL = 3.29).

With the superior score on PjBL, working on long, multi-step projects would arguably provide more reliable chances for analysis, planning, and decision-making. In the case of grade 8 students in the Nail Care services, projects like the composition of the nails took time from analyzing what their project is and planning on how to make their project using recycled materials. Yet consider that previous research, such as Banfield and Wilkerson (2018), attributes analytical development to PBL based on its problem-solving focus—suggesting that the variability in this study may be situational or a result of the structure of the Nail Care curriculum used.

Generally, both PBL and PjBL are viewed by respondents as effective pedagogies in achieving significant learning outcomes in Nail Care services. However, Project-Based Learning enjoys a narrow lead, particularly when it comes to the acquisition of practical skills, communication, teamwork, and analytical skills. These observations highlight the importance of experiential, student-centered learning in technical-vocational education and support calls for the convergence of the two pedagogies such that the best of both are integrated to support student development. Such findings are consistent with broader trends in education indicated by extant research (Hmelo-Silver, 2017; Thomas & Thorne, 2019; Banfield & Wilkerson, 2018), endorsing participatory, experiential, and social learning environments in skill-based instruction.

Table 5. Perception of the Respondents as to Learning Expectations

Indicator	Problem-Based			Project-Based		
	Mean	SD	VI	Mean	SD	VI
Problem/Project-based learning….						
1. prepares me adequately for exams and assessments.	3.40	0.74	Agree	3.60	0.55	Strongly agree
2. helps me meet my personal learning goals.	3.34	0.73	Agree	3.11	0.68	Agree

3.	helps me gain practical knowledge that is relevant to TLE area.	3.31	0.72	Agree	3.23	0.81	Agree
4.	helps me develop the necessary skills for my future career.	3.49	0.74	Agree	3.26	0.56	Agree
5.	provided constructive feedback from teachers to improve my performance.	3.51	0.66	Strongly agree	3.51	0.51	Strongly agree
Over-all		3.41	0.49	Agree	3.34	0.40	Agree

Legend: *3.50-4.00 (Strongly Agree), 2.50-3.49 (Agree), 1.50-2.49 (Disagree), 1.00-1.49 (Strongly disagree)*

Table 5 reports students' views on how Problem-Based Learning (PBL) and Project-Based Learning (PjBL) support them in fulfilling their learning expectations in the context of services for Nail Care. Overall findings show both methods were graded a mean of "Agree", though marginally higher for PBL (3.41) compared to PjBL (3.34), pointing to the fact that respondents do view PBL as more helpful in supporting their academic and career development goals.

The highest rated metric for both approaches is "providing constructive teacher feedback to improve performance," which was rated "Strongly Agree" (mean = 3.51 for both). This is in line with the pivotal role played by teacher feedback in allowing students to reflect and improve their work during the course of the lesson, be it on the Problem-based learning (PBL) or the Project-based learning(PjBL)—an observation attested to by Hmelo-Silver (2017), who emphasized the importance of facilitated feedback in student-directed learning settings like PBL and PjBL. Constructive comments are particularly necessary for technical courses like Nail Care, where technical skills and precision are continuously refined.

Students also believed that both approaches equip them for examinations and assessments, and PjBL (mean = 3.60) scored "Strongly Agree," only marginally higher than PBL (mean = 3.40). This is a sign that practical application holistic projects allow students to recall and apply information better so that they can easily pass official examinations. Wurdinger & Qureshi (2016) agree with this by indicating that project-based learning translates into long-term retention of learning, which comes in the form of enhanced test performance.

In the case of fulfilling individual learning goals, PBL (mean = 3.34) did better than PjBL (mean = 3.11). It is a sign that students are more intellectually and academically contented while engaging in problem-solving exercises that mentally challenge them and allow them to learn independently. Taking the cue from Belland et al. (2017), there exists more room for inquiry learning within PBL learning environments that facilitate goal-setting as well as independent learning routes.

Regarding gaining hands-on experience in connection with the TLE (Technology and Livelihood Education) especially Nail Care Technician profession, both methods equally received good but mediocre ratings—PBL (mean = 3.31) slightly greater than PjBL (mean = 3.23). This is opposite to the prevailing supposition that PjBL would be automatically more practical and applicative. Both may have practical elements in Nail Care training, but PBL may be including more realistic problem situations reflective of daily challenges faced in careers in beauty services.

In career skill development, PBL again scored higher (mean = 3.49) than PjBL (mean = 3.26), which suggests that students believe that contextualized problem-solving better prepares them for the workforce. This may be due to decision-making skills, flexibility, and analytical skills being of high importance in PBL. Banfield and Wilkerson (2018) also supported this finding by contending that PBL facilitates career readiness through the development of higher-order thinking and self-efficacy.

Both PBL and PjBL are favorable in the aspect of assisting students to achieve their learning goals for Nail Care services. Slight bias is towards PBL as regards career development, personal goal achievement, and achieving appropriate knowledge. The results indicate that a blending of the two pedagogies would be best used in technical-vocational education contexts such as TLE, wherein both theory and competence in practical work are equally stressed. These findings agree with existing research (Hmelo-Silver, 2017; Belland et al., 2017; Wurdinger & Qureshi, 2016) that promotes integrative and student-centered education models to have the greatest effect on education.

Table 6. Respondents' Level of Engagement in terms of Cognitive

Indicator	Problem-based		Project-based	
	Before	After	Before	After
	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI
1. I try to understand challenging concepts that are taught in class	3.26 (0.66) Engaged	3.46 (0.61) Engaged	3.29 (0.46) Engaged	3.46 (0.51) Engaged

2. I evaluate and critically analyze the materials utilized in TLE.	3.49 (0.61) Engaged	3.66 (0.48) Highly Engaged	3.23 (0.49) Engaged	3.43 (0.56) Engaged
3. I connect new information with what I already know.	3.29 (0.83) Engaged	3.46 (0.74) Engaged	3.23 (0.55) Engaged	3.43 (0.61) Engaged
4. I frequently discover solutions to tough TLE -related challenges or problems.	3.23 (0.73) Engaged	3.26 (0.7) Engaged	3.34 (0.59) Engaged	3.49 (0.61) Engaged
5. I engage in debates and group activities that require critical thinking.	3.37 (0.81) Engaged	3.4 (0.77) Engaged	3.23 (0.43) Engaged	3.34 (0.48) Engaged
Over-all	3.33 (0.49) Engaged	3.45 (0.38) Engaged	3.26 (0.22) Engaged	3.43 (0.32) Engaged

Legend: *3.50-4.00 (Highly Engaged), 2.50-3.49 (Engaged), 1.50-2.49 (Moderately Engaged), 1.00-1.49 (Not engaged)*

Table 6 is a comparison of students' cognitive engagement prior to and subsequent to exposure to Problem-Based Learning (PBL) and Project-Based Learning (PjBL) for the setting of Nail Care services. Cognitive engagement has been described as students' investment in learning, e.g., their willingness to use mental effort, to analyze, to relate concepts, and to solve problems. Findings indicate participants were overall "Engaged" across all measures in both learning environments with no statistical increases in engagement scores after the intervention, specifically in the PBL group. On all five cognitive aspects, the PBL method showed a rise from pre-intervention mean 3.33 to post-intervention mean 3.45, both in the "Engaged" category. The highest value improvement was in the statement "I evaluate and critically analyze the materials used in TLE," with the mean improving from 3.49 (Engaged) to 3.66 (Highly Engaged).

Likewise, PjBL also had good results, from pre-intervention total mean of 3.26 to 3.43 post-intervention, which is under the "Engaged" category. To our surprise, the PjBL group students achieved the highest post-test score of 3.49 in "uncovering solutions to TLE-related problems," which is an indication that project-based learning through experiential, real-life practice improves problem-solving capacity. This is in agreement with Thomas and Thorne (2019), where they discovered that PjBL significantly improves practical application and decision-making in cosmetology schools.

For both learning strategies, improvement of connecting new knowledge to existing experience, and group work with critical thinking, also occurred with increasingly increasing post-test scores. This concurs with Banfield and Wilkerson (2018), who are proponents of experiential and collaborative education for career and technical education, since both PBL and PjBL facilitate knowledge integration and peer-to-peer learning.

Notably, despite the slightly faster growth in PBL cognitive participation overall, much growth was observed for PjBL as well, particularly with those areas that are related to problem-solving and application of learned skills. What this would seem to indicate is that while PBL may more readily lend itself to individual enhancement of critical thought and analysis, PjBL facilitates participation with engaged, joint learning activities—an important element for Nail Care service training with the focus on collaborative training and hands-on training.

Lastly, both PBL and PjBL were successful in promoting students' cognitive engagement in Nail Care services, with the former demonstrating marginally greater superiority on the analytical and evaluative dimensions, and the latter showing strengths on the practical problem-solving and active engagement. These findings support previous studies that highlight the important role of learner-centered teaching methods in technical-vocational education (Hmelo-Silver, 2017; Belland et al., 2017; Thomas & Thorne, 2019). An integrated approach using both strategies can provide the most appropriate mixed and rational framework for creating cognitively active students under the TLE program.

Table 7 illustrates the affective engagement of the respondents—i.e., their emotional engagement, learning interest, motivation, and enjoyment—before and after Problem-Based Learning (PBL) and Project-Based Learning (PjBL) interventions were introduced on Nail Care services. As can be observed from the findings, the students were always "Engaged" on all the affective measures, both before and after interventions. There is a significant difference in engagement after the intervention between both types of learning, with Project-Based Learning scoring marginally ahead on total affective gain.

Table 7. Respondents' Level of Engagement in terms of Affective

Indicator	Problem-based		Project-based	
	Before	After	Before	After
	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI

1. Listening to lectures and participating in TLE activities excites me.	3.31 (0.63) Engaged	3.46 (0.56) Engaged	3.31 (0.53) Engaged	3.49 (0.51) Engaged
2. I feel a sense of accomplishment after completing a challenging assignment or projects in TLE.	3.49 (0.78) Engaged	3.6 (0.65) Engaged	3.11 (0.63) Engaged	3.29 (0.67) Engaged
3. I emotionally connect with the subject matter that is being taught.	2.83 (0.82) Engaged	3 (0.69) Engaged	3.23 (0.49) Engaged	3.31 (0.47) Engaged
4. I am motivated to perform well academically and achieve my goal.	3.29 (0.89) Engaged	3.46 (0.7) Engaged	3.14 (0.49) Engaged	3.4 (0.55) Engaged
5. Positive emotions come to me while learning.	3.31 (0.87) Engaged	3.37 (0.77) Engaged	3.14 (0.55) Engaged	3.46 (0.51) Engaged
Over-all	3.25 (0.54) Engaged	3.38 (0.42) Engaged	3.19 (0.27) Engaged	3.39 (0.33) Engaged

Legend: *3.50-4.00 (Highly Engaged), 2.50-3.49 (Engaged), 1.50-2.49 (Moderately Engaged), 1.00-1.49 (Not engaged)*

For PBL, total affective engagement also rose from 3.25 to 3.38, and PjBL from 3.19 to 3.39, both still in the "Engaged" category according to rating scale. This indicates both methods proved capable of building students' emotional interest and enthusiasm in Nail Care learning activities. The highest influential statement in PBL was for, "I feel a sense of accomplishment after completing a difficult activity or project in TLE," increasing from 3.49 to 3.60. This corroborated with Banfield and Wilkerson's (2018) paper, wherein they asserted that problem-based learning matures a sense of ownership and accomplishment by moving towards the resolution of actual problems. Within Nail Care, whichever activity like working on nail artwork or addressing cleanliness is hands-on and client-related, having it done provides in-house satisfaction.

With PjBL, the most salient increase emerged within "Positive emotions come to me while learning" from 3.14 to 3.46 in which students were self-reporting a sense of pleasure and happiness in engaging in task-oriented activity. This is reinforced by Thomas and Thorne (2019), whereby vocational learners had increased emotional involvement and pleasure in the topic through project-based group work. The real-life nature of PjBL—where students can fantasize salon practice or create portfolios for beauty treatment—gives meaning and emotionally rewarding learning. Particularly, emotional investment in the subject matter (Statement 3) was lower for PBL (2.83) compared to PjBL (3.23) prior to intervention but increased for both approaches after intervention. This indicates that PjBL may establish stronger emotional connections to content at first, possibly due to projects being interactive and customized. As Wurdinger and Qureshi (2016) note, the students are going to engage more emotionally in the learning if activities are reproducing real life situations and appear significant or of aesthetic expressiveness.

Both approaches also resulted in higher academic motivation of the students (Statement 4), and post-test was at 3.46 (PBL) and 3.40 (PjBL). This is consistent with previous studies by Hmelo-Silver (2017), who had found that student-centered pedagogies increase motivation because it provides a sense of control, relevance, and meaning while learning for the students.

Finally, Problem-Based Learning and Project-Based Learning both positively affect the affective involvement of students with Nail Care services. PBL creates a deep feeling of achievement and motivation, with PjBL incorporating other positive affect and emotional commitment to the subject matter. While both methods were equally effective at sustaining an "Engaged" state, PjBL experienced slightly greater increases in post-intervention affective involvement, especially on enjoyment, emotional commitment, and learning satisfaction.

The practices underlie the premise by Banfield & Wilkerson (2018) and Thomas & Thorne (2019) that affective involvement significantly matters in technical education, particularly in learning sessions like Nail Care where the performance of the student significantly relies on individual interest, imagination, and emotional involvement. Combining the two approaches through TLE activity will allow more sense of bonding emotionally towards education to take effect for the learners, their experience more enjoyable and richer.

Table 8 explores students' behavioral engagement in Nail Care services before and after experiencing Problem-Based Learning (PBL) and Project-Based Learning (PjBL) strategies. Behavioral engagement is illustrated through observable actions such as attendance, participation, submission of tasks, and collaboration with others. Collectively, both treatments generated increased behavior engagement, PBL from "Engaged" (mean = 3.34) to "Highly Engaged" (mean = 3.53), while PjBL improved from 3.24 to 3.50 to reach the same level of being "Highly Engaged" as well, following the treatment

As compared to PBL, learners recorded significant improvement on multiple behavior metrics. The greatest gain was on the item, "I actively contribute to group projects and class discussions," which increased from 3.40 to 3.69—a shift from "Engaged" to "Highly Engaged." This was in consonance with Hmelo-Silver (2017), who emphasized that problem-based learning facilitates more deep engagement since the students working in small groups address

open-ended, real-world problems of the actual world. In nail care training, this might involve collaboration on practice client services or sanitation processes, both of which are collaborative and accountable

Table 8. Respondents' Level of Engagement in terms of Behavioral

Indicator	Problem-based		Project-based	
	Before	After	Before	After
	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI
1. I arrive on time for class.	3.57 (0.7) Highly Engaged	3.74 (0.56) Highly Engaged	3.31 (0.53) Engaged	3.57 (0.5) Highly Engaged
2. I actively participate in group projects and class discussions.	3.4 (0.65) Engaged	3.69 (0.53) Highly Engaged	3.11 (0.63) Engaged	3.49 (0.51) Engaged
3. I submit projects and complete them on time.	2.97 (0.68) Engaged	3.09 (0.89) Engaged	3.14 (0.6) Engaged	3.34 (0.48) Engaged
4. I participate in extracurricular activities or events outside or regular school day.	3.26 (0.85) Engaged	3.54 (0.66) Highly Engaged	3.4 (0.6) Engaged	3.69 (0.47) Highly Engaged
5. I collaborate with classmates on academic tasks.	3.51 (0.74) Highly Engaged	3.6 (0.74) Highly Engaged	3.23 (0.6) Engaged	3.4 (0.6) Engaged
Over-all	3.34 (0.54) Engaged	3.53 (0.49) Highly Engaged	3.24 (0.37) Engaged	3.5 (0.29) Highly Engaged

Legend: *3.50-4.00 (Highly Engaged), 2.50-3.49 (Engaged), 1.50-2.49 (Moderately Engaged), 1.00-1.49 (Not engaged)*

Additionally, PBL students also showed impressive performance in attendance and punctuality, with scores for "I arrive on time for class" increasing from 3.57 to 3.74. This increase signifies increased responsibility and motivation to learn, a behavioral outcome also found in Wurdinger & Qureshi (2016), where students in active learning environments were more punctual and prepared since they had more personal investment. The same gains were observed for PjBL. The deepest change occurred in the item, "I engage in extracurricular activities or activities outside the standard school day," from 3.40 to 3.69—moving to "Highly Engaged." This result reflects the community and real-world emphasis of project-based learning, where students are able to display their nail art, instruct techniques at school fairs, or mimic a salon experience. As pointed out by Thomas and Thorne (2019), PjBL has a tendency to motivate students to extend their learning beyond the classroom, forming professional dispositions and public engagement.

Though the on-time submission of the project was still in the "Engaged" column for the two groups, the PjBL group did reflect a notable betterment (from 3.14 to 3.34). This is a sign of better time management and responsibility, likely because of the structured deadlines and collaborative nature of project-based work, as highlighted by Belland et al. (2017). Both methods also had a positive effect on peer collaboration. In PBL, the measure "I work with peers on school work" averaged a high 3.51 prior to and 3.60 subsequently, retaining "Highly Engaged" ranking. Students tend to answer problems related in Nail care services when they are grouped in pairs or more.

Table 9. Respondents' Level of Engagement in terms of Agentic

Indicator	Problem-based		Project-based	
	Before	After	Before	After
	Mean(SD) VI	Mean (SD) VI	Mean (SD) VI	Mean (SD) VI
1. I have well -defined academic goals for myself.	3.4 (0.6) Engaged	3.49 (0.56) Engaged	3.06 (0.59) Engaged	3.43 (0.61) Engaged
2. I accept responsibility for my educational growth.	3.4 (0.69) Engaged	3.46 (0.7) Engaged	3.29 (0.52) Engaged	3.6 (0.5) Highly Engaged
3. I seek feedback from teachers to improve my performance.	3.23 (0.77) Engaged	3.34 (0.76) Engaged	3.37 (0.49) Engaged	3.49 (0.51) Engaged

4. I give academic tasks priority and effectively organize my time.	3.43 (0.74) Engaged	3.43 (0.74) Engaged	3.4 (0.6) Engaged	3.49 (0.56) Engaged
5. I employ a range of tools, including online and library resources, to enhance my understanding of the topic.	3.31 (0.8) Engaged	3.34 (0.8) Engaged	3.37 (0.6) Engaged	3.4 (0.6) Engaged
Over-all	3.35 (0.52) Engaged	3.41 (0.52) Engaged	3.3 (0.34) Engaged	3.48 (0.35) Engaged

Legend: *3.50-4.00 (Highly Engaged), 2.50-3.49 (Engaged), 1.50-2.49 (Moderately Engaged), 1.00-1.49 (Not engaged)*

The table indicates the self-assessment levels of students' agentic engagement- that is, students' active role in managing their learning -before and after engaging in PBL and PjBL. Both methods show a positive trend of agentic engagement with significant improvements in self-regulation, responsibility for one's own learning, and the use of resources among the students. For the case of PBL, students improved moderately in terms of setting academic goals, increasing from a mean of 3.40 before and 3.49 after. It means that PBL may stimulate the students to approach their studies with a more goal-oriented attitude. PjBL also showed a small increase in academic goal setting by its students (3.06 to 3.43), although the improvement was not as striking as in the case of PBL. This is consistent with a review indicating that PBL facilitates learner autonomy but that the characteristics of the activities undertaken could impact on the level of learner initiative displayed by the student (Bell, 2016).

Moreover, PBL and PjBL students tended to become more personally responsible for their learning. Compared to their earlier stages, taking responsibility for one's learning progression increased from 3.40 to 3.46 for PBL students, but the increase of PjBL was bigger in magnitude, 3.29 to 3.60. This means project -based learning may better support ownership over results. The finding supports more recent studies on how PjBL helps the students make control of their own academic development by using real -world, hands -on projects (Robertson and Robertson 2022). The latter, however sought teacher feedback for improvement, increasing in both groups; PBL rose from 3.23 to 3.34 while PjBL increased from 3.37 to 3.49. Both of these seem to encourage active interaction with the teacher for improved performance, an outcome aligned with the premise that PBL and PjBL alike support iterative learning with constant feedback (Mergendoller et al., 2019).

Time management and resource utilization were also enhanced. Both the PBL and PjBL groups showed continuous engagement in effective time management (3.43 to 3.43 for PBL and 3.40 to 3.49 for PjBL). More importantly, the improvement of resource use for both approaches to enhance understanding was only minimal, indicating that while both PBL and PjBL facilitate an active learning setting, the utilization of resources by the students may still be affected by variables other than the design of the learning process itself (Bae & Lee, 2020).

Overall, both PBL and PjBL affected students' agentic engagement positively, and the students showed greater activity and participation in the learning process with a sense of responsibility, requesting feedback, and controlling time. Such results are consonant with a large number of emerging research studies highlighting the importance of active, student-centered learning approaches that support self-regulation and personal agency in class.

Table 10. Respondents' Level of Technical Competence

Score	Problem-Based				Project-Based				
	Pretest		Post-test		Pretest		Post-test		VI
	f	%	f	%	f	%	f	%	
90-100	-	-	2	5.8	-	-	3	8.7	Outstanding
85-89	-	-	2	5.7	-	-	4	11.4	Very Satisfactory
80-84	-	-	3	8.6	1	2.9	4	11.5	Satisfactory
75-79	-	-	5	14.3	1	2.9	4	11.5	Fairly Satisfactory
Below 75	35	100	23	65.8	33	94.7	20	57.4	Did not meet expectations
TOTAL	35	100	35	100	35	100	35	100	

Legend: 90-100 (Outstanding), 85-89 (Very Satisfactory), 80-84 (Satisfactory), 75-79 (Fairly Satisfactory), Below 75 (did not meet expectations)

The data in Table 10 present the technical competence of the participants in two forms of instructional methods—Problem-Based Learning (PBL) and Project-Based Learning (PjBL)—pre- and post-interventions, in terms of pretest and posttest scores. The table categorizes these results into five levels of performance: Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory, and Did Not Meet Expectations, each representing a particular range of scores. For Problem-Based Learning (PBL), most of the participants (100%) in the pretest were less than 75, which means that they began with low technical competence in terms of written exam. When exposed to the PBL intervention, only 65.8% of the participants were still less than 75, and the rest of the participants were in the Fairly Satisfactory and Satisfactory ranges, with a few participants in the Very Satisfactory range. This means that the PBL method caused some improvement, although the number of participants in the higher ranges (Outstanding and Very Satisfactory) was minimal. For Project-Based Learning (PjBL), the performance was higher, with 57.4% of participants scoring less than 75 in the posttest. More participants were successful at the Satisfactory and Very Satisfactory levels in PjBL than in PBL, and even some participants were successful at the Outstanding level (8.7%). This shows that PjBL can be more effective in achieving a higher technical capability than PBL.

These findings are supported by recent research. Savery (2015) and Han et al. (2020) emphasized that Project-Based Learning produces greater engagement and performance outcomes, particularly in technical areas, because it is real-world centered and experiential, and it entails group problem solving. Akgun and Yildirim (2016) also determined that PjBL was more effective than PBL in increasing the technical ability of students, as it entails practical problems that are similar to real professional work. While PBL also requires active learning, it might be less structured, and the lack of apparent, tangible outcomes might make it less effective in developing technical skills, as proposed by Savery (2015).

Overall, while both PBL and PjBL supported the development of technical ability, the studies indicate that PjBL is more effective than PBL in terms of challenging participants to higher levels of expertise. This is perhaps because the more formal, project-based method of PjBL presumably more accurately simulates the learning of practical skills required for technical skills. Further studies, including Han et al. (2020) and Kurt et al. (2019), further emphasize the strengths of Project-Based Learning in producing skill-based outcomes.

Table 11. Test of Difference in the Level of Students' Engagement Before Using Problem-Based and Project-Based

Level of Engagement	Problem-Based		Project-Based		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Cognitive	3.33	0.49	3.26	0.22	.694	68	.490
Affective	3.25	0.54	3.19	0.27	.558	68	.579
Behavioral	3.34	0.54	3.24	0.37	.934	68	.354
Agentic	3.35	0.52	3.30	0.34	.542	68	.590

Legend: P<0.05 (Significant); P> 0.05 (Not Significant)

Table 11 indicates that Grade 8 students' levels of engagement were not even prior to Problem-Based Learning (PBL) and Project-Based Learning (PjBL) implementation in nail care services. Cognitive, affective, behavioral, and agentic were the four dimensions of student engagement that were measured; each had a mean score and standard deviation for both learning modes. On all three dimensions, Problem-Based Learning yielded slightly higher mean scores than Project-Based Learning. Cognitive engagement, for example, earned a mean rating of 3.33 (SD = 0.49) under PBL, but was slightly lower at 3.26 (SD = 0.22) under PjBL. The same marginal difference was found with affective (PBL = 3.25, PjBL = 3.19), behavioral (PBL = 3.34, PjBL = 3.24), and agentic engagement (PBL = 3.35, PjBL = 3.30).

The t-tests indicated no statistical differences across any of the engagement facets since all the p-values were greater than the 0.05 significance level (e.g., cognitive: p = .490, affective: p = .579). This indicates that although PBL could have a slight edge in student engagement measures, the differences are not large enough to create advantage for either method over the other. This conclusion agrees with the research on synergistic advantages of PBL and PjBL in enhancing student engagement. Although their effects may not vary significantly in a brief intervention, Chen and Yang's (2019) paper emphasizes the way that PBL and PjBL encourage critical thinking and independence of learners. In the same way, Belland et al. (2017) established that PjBL encourages creativity as well as collaborative learning, while PBL encourages inquiry and problem-solving-features which have different but equally significant impacts on engagement.

Table 12. Test of Difference in the Level of Students' Engagement After Using Problem-Based and Project-Based Learning

Level of Engagement	Problem-Based		Project-Based		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Cognitive	3.45	0.38	3.43	0.32	.204	68	.839
Affective	3.38	0.42	3.39	0.33	-.127	68	.899

Behavioral	3.53	0.49	3.50	0.29	.357	68	.722
Agentic	3.41	0.52	3.48	0.35	-.651	68	.517

Legend: P<0.05 (Significant); P> 0.05 (Not Significant)

Data presented in Table 12 provides the results of statistical comparison of students' level of engagement after going through Problem-Based Learning (PBL) and Project-Based Learning (PjBL) approaches. The types of engagement that have been compared are cognitive, affective, behavioral, and agentic engagement. Each of these types of engagement was checked for mean differences between the two teaching methods through a t-test for independent samples. In all four engagement areas, the p-values are greater than 0.05, which means that there are no statistically significant differences between these two teaching methods with regard to their impact on student engagement.

The average scores in the cognitive engagement were almost similar PBL with an average of 3.45 and PjBL with an average of 3.43 and a significance level of p = 0.839, indicating that both approaches equally facilitate students' mental commitment to learning activities. Whereas mean scores of PBL affective engagement is 3.38 and that of PjBL is 3.39 and a p value of 0.899 indicate zero emotional differences between how students perceived the learning activities.

For the behavioral engagement, the averages of 3.53 for PBL and 3.50 for PjBL, and p value of 0.722, students' effort and involvement in classroom activities were similar using both approaches. For the agentic engagement, it is students' active contribution to their learning context, also had no difference under PBL with a mean of 3.41, PjBL with 3.48; p value of 0.517. These results concur with the available literature identifying both PBL and PjBL as successful, student-focused methods of instruction that promote student engagement but in somewhat distinct ways (Zhao & Chan, 2020; Bell, 2016). Whereas PBL is concerned with open-ended problem-solving and encouraging critical thinking, PjBL prioritizes the production of tangible outcomes through extended inquiry (Kokotsaki, Menzies, & Wiggins, 2016). Yet, as this research shows, neither method is equally effective at inducing greater levels of engagement, at least in the measured context.

The evidence in Table 13 below indicates a statistically significant increase in Grade 8 students' engagement in Nail Care Services following the use of Problem-Based Learning (PBL). Four engagement dimensions—cognitive, affective, behavioral, and agentic—were assessed prior to and following the intervention. Post-implementation mean scores were higher on all dimensions, and all related p-values are below 0.05, which implies statistical significance of the improvements. With t = -3.340 and p =.002, the mean score for cognitive engagement rose from 3.33 (SD = 0.49) to 3.45 (SD = 0.38). This would indicate that PBL had a significant effect on students' application ability, thinking, and reasoning. Affective engagement also increased from 3.25 to 3.38 (p =.004), which could indicate that the students felt more of a stronger positive emotional attachment to the task of learning, perhaps due to the applicability and practical guide that PBL provides.

Table 13. Test of Difference in the Level of Students' Engagement Using Problem-Based Learning

Level of Engagement	Before		After		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Cognitive	3.33	0.49	3.45	0.38	-3.340	34	.002
Affective	3.25	0.54	3.38	0.42	-3.088	34	.004
Behavioral	3.34	0.54	3.53	0.49	-2.922	34	.006
Agentic	3.35	0.52	3.41	0.52	-2.253	34	.031

Legend: P<0.05 (Significant); P> 0.05 (Not Significant)

Also, there was an increase in behavioral engagement from 3.34 to 3.53 (p =.006) signifying increases in activity, interest, and persistence towards nail care, an activity characteristic of PBL's active learning philosophy where learners have the opportunity to independently and independently solve everyday life problems. Last, student's agentic participation or being in control in learning activities increased from 3.35 to 3.41 (p =.031) implying greater student autonomy and capacity to determine the nature of the learning processes that they followed.

Belland et al. (2017) pointed out that PBL enhances deep learning through problem-solving and inquiry, and it encourages more cognitive and behavioral engagement. Similarly, Hung (2016) stressed the significance of PBL in fostering learner autonomy and affective motivation, which is reinforced by the affective and agentic score increases in this research.

Considering the implementation of Project-Based Learning (PjBL), the number of Grade 8 students engaged in nail care services increased statistically significantly, as revealed by Table 14. It is evident from the results that the PjBL intervention significantly enhances the four primary aspects of participation: cognitive, affective, behavioral, and agentic. P-values are < 0.05.

Table 14. Test of Difference in the Level of Students' Engagement Using Project-Based Learning

Level of Engagement	Before		After		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Cognitive	3.26	0.22	3.43	0.32	-3.216	34	.003
Affective	3.19	0.27	3.39	0.33	-3.450	34	.002
Behavioral	3.24	0.37	3.50	0.29	-4.807	34	.000
Agentic	3.30	0.34	3.48	0.35	-3.554	34	.001

Legend: P<0.05 (Significant); P> 0.05 (Not Significant)

Students' average scores on cognitive engagement rose from 3.26 (SD = 0.22) to 3.43 (SD = 0.32) for the difference in their scores from the pretest to the post-test, with p-value of.003. This reflects how PjBL enhanced students' knowledge of the curriculum content, critical thinking, and problem-solving in real-world contexts. Moreover, emotional engagement of the students grew dramatically from 3.19 to 3.39 (p =.002), indicating that they were engaged in and had fun with learning. This was presumably since the projects were imaginatively and purposefully planned and conducted.

The behavioral engagement factor demonstrated the greatest gain—from 3.24 to 3.50 (p =.000)—indicating that students became more actively engaged, consistent, and participatory in PjBL activities. This aligns with the essence of project-based learning, which requires collaboration, planning, and effort over time. Finally, an increase in agentic engagement from 3.30 to 3.48 (p =.001) demonstrated that students were more capable of taking initiative, making choices, and co-creating their learning pathways.

These results underline the positive effects of PjBL on the cognitive, affective, behavioral, and agentic engagement of students. Hence, more engagement at the cognitive level manifests in terms of resultant critical and problem-solving skills by PjBL in the view of Thomas (2018), which says that PjBL involves the students in deeper inquiry about content and promotes critical thinking. An increase in affective engagement reveals that students are emotionally charged about their learning and reflects the findings of Bell (2016) work when the author suggests that PjBL promotes motivation through meaningful and pleasing experiences. The behavioral engagement is on the rise, which implies increased participation and effort in performing work on tasks, with findings echoed in the studies of Chen and Yang (2019), as they explain how PjBL fosters teamwork and participation. Additionally, since PjBL engages students in self-directed and self-controlled learning, according to Hmelo-Silver and Barrows (2018), the increase in agentic engagement indicates that PjBL promotes student autonomy and responsibility in learning.

Table 15. **Test of Difference in the Technical Competence of Students Using Problem-Based Learning and Project-based Learning**

Technical Competence	Before		After		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Problem-Based Learning	19.11	4.81	32	8.37	-11.107	34	000
Project-based Learning	20.8	6.99	34.49	7.63	-9.443	34	000

Legend: P<0.05 (Significant); P> 0.05 (Not Significant)

Table 15 provides a comparison of the result of a comparative study of Grade 8 students' technical competency in Nail Care Services before and after the implementation of Problem-Based Learning (PBL) and Project-Based Learning (PjBL). From the findings, it is clear that both learning strategies significantly improved students' technical skills as evident from the highly significant mean score improvements as well as the highly significant p-values (both = 0.000), which are well below the 0.05 significance level cutoff.

In the case of Problem-Based Learning, technical competence scores of the students increased sharply from a mean of 19.11 (SD = 4.81) to 32.00 (SD = 8.37). Such improvement indicates the extent to which PBL, with its actual scenarios of problems from real life, probably boosted students' capabilities

for applying theoretical concepts in actual settings. PBL generally comprises studying salon-based issues (e.g., customer discontent, poor sanitation) and coming up with the right solutions to nail care problems, fostering practical skill building and critical thinking.

For Project-Based Learning as well, students showed a significant increase—from 20.8 (SD = 6.99) to 34.49 (SD = 7.63). PjBL targets the manufacture of concrete products—such as nail art displays, hygiene packs, or mini-spa treatments—where continuous practice, collaboration, and improvement of technical know-how are required. The results suggest that the recursive, performance-based nature of PjBL facilitated the stabilization of accuracy, hand coordination, and procedure proficiency.

These results are validated by recent education literature. Boss and Larmer (2018) claim that project-based learning environments themselves develop technical and vocational skills through their hands-on, student-controlled approach. In a similar fashion, Hung (2016) and Chen and Yang (2019) also emphasize that PBL facilitates transfer of skills through its engagement of students in valuable, problem-based tasks that emulate vocational challenges under actual conditions for example, in the case of Nail Care. Both approaches are reported to promote genuine, active learning, which is essential in Technology and Livelihood Education classes that seek to prepare students with employment-ready skills.

Overall, both PBL and PjBL immensely enhance students' technical proficiency in Nail Care Services. Although the post-test mean score for PjBL is higher than for PBL, this statistical difference is not analyzed here. Regardless, the figures are convincing proof of the employment of both teaching methodologies in teaching TLE in order to achieve optimum acquisition of career-specific vocational skills among junior high school students.

Table 16 provides a comparative analysis of Grade 8 students' technical competence in Nail Care Services prior to and following the adoption of Problem-Based Learning (PBL) and Project-Based Learning (PjBL). The analysis assesses whether there is a significant difference in student performance between the two approaches at the pre- and post-intervention levels.

Before the use of PBL and PjBL, students' mean technical competence scores were 19.11 (SD = 4.81) for PBL and 20.8 (SD = 6.99) for PjBL. The p-value of 0.244 indicate no statistically significant difference in students' technical skills prior to the intervention. This implies that both groups started with comparable skill levels, supporting the fairness of comparing the two teaching methods.

Following implementation, mean scores were significantly enhanced in each group (as indicated in previous tables), with PBL increasing to 32.00 (SD = 8.37) and PjBL increasing to 34.49 (SD = 7.63). However, the post-intervention comparison also shows no statistically significant difference between the two methods (p = 0.198). Both methods begin with the same level of technical competence and with the same improvement after the implementation of Problem-based learning and project-based learning.

Table 16. Test of Difference in the Technical Competence of Students Before and After Using Problem-Based and Project-Based Learning

Technical Competence	Problem-Based		Project-Based		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Before Using Problem and Project-based learning	19.11	4.81	20.8	6.99	-1.175	68	0.244
After using Problem and Project-based learning	32	8.37	34.49	7.63	-1.299	68	0.198

Legend: P<0.05 (Significant); P> 0.05 (Not Significant)

This is supported by studies such as Kokotsaki, Menzies, and Wiggins (2016) and Chen and Yang (2019), which concluded that both PBL and PjBL develop technical and applied skills, specifically in skill-oriented, practical fields such as vocational education. Hung (2016) also indicated that PBL promotes deep learning through authentic problem-solving, while PjBL promotes skill reinforcement through extensive, project-guided practice. While both processes use varying instruction techniques, both construct authentic learning settings that translate to measurable skill acquisition.

Based on the data of Table 16, information tells us that both PBL and PjBL equally increase technical skill profoundly but with equal though not drastically significant difference from one another in effect. That hypothesis lays out that teachers may select either methodology—or a blended one—naturally based upon setting, assets, or acquiring aims and the fact that they equally result into a similarly higher acquisition of Grade 8 students' technical skill through learning.

5. Conclusions

The study revealed that there is no significant difference between the students' level of engagement before using and after using Problem-based learning and Project- based learning. There is a significant difference in the levels of engagement within the problem-based and project-based group before and after the use of problem-based and project-based learning. The scores in the technical competence of the two learning groups differ significantly before and after the use of problem-based learning and problem-based learning.There is no significant difference in the pre and post test scores within the problem-based learning and project-based learning groups.

6. Recommendations

Educators may ensure balanced strategy of engagement for Problem-based learning as well as Project-based learning to create exciting learning experiences for all the learners. Teachers may adapt learning activities involving both Problem-based learning and Project-based learning such as real-life problem-solving exercises and hands-on projects and can stress developing collaborative features to further build group work, peer contact, and knowledge application in everyday life.

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