Integration of Problem-based and Project-based Learning (PPBL): Its Effect on the Entrepreneurial Skills of Grade 9 TVE Students

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Abstract

The education system offers a variety of options for young citizens, and the teachers have the responsibility to motivate young aspirants to become entrepreneurs. There have been numerous concepts that fall particularly within technical-vocational education (TVE) programs, such as Project-Based and Problem-Based Learning, which are in the sense of fostering an entrepreneurial mindset. This study primarily aims to assess the effect of the integration of problem-based and project-based learning on the entrepreneurial skills of Grade 9 technical-vocational education (TVE) students at Malvar School of Arts and Trade. Specifically, this study sought to answer the pre-test scores and post-test scores of the student-respondents on critical thinking, creativity and innovation, teamwork, and resilience, the level of student-respondents' entrepreneurial skills in project-based learning using a rubric, and the level of effectiveness of problem-based and project-based learning on the entrepreneurial skills of Grade 9 technical-vocational education (TVE) students. The study concluded that there is a significant difference between the pre-test and post-test scores of student-respondents on critical thinking, creativity and innovation, teamwork, and resilience, and there is no significant difference between the entrepreneurial skills of student-respondents exposed to project-based learning.

Keywords: Entrepreneurial Skills; Problem-based Learning; Project-based learning; Problem-based and Project-based Learning (PPBL); Critical Thinking; Creativity and Innovation; Teamwork; Resilience.

1. Introduction

In the global context, there have been fundamental shifts in educational systems, leading to many pedagogies and strategies that are adaptive to 21st-century skills, including critical thinking, creativity, modernization, and entrepreneurship. These learner-centered pedagogies emphasize real-world problem-solving, active inquiry, and hands-on experiences, which consistently build great strength in preparing students for future work in the present era. In recent years, there have been numerous concepts that fall particularly within technical-vocational education (TVE) programs, and this is in the sense of an entrepreneurial mindset. This mindset is significant in strengthening and enhancing not only academic performance but also innovation, self-direction, and business sense in the students.

In the Philippines, K to 12 education aims to develop lifelong skills, such as entrepreneurship, through Technology and Livelihood Education (TLE) and Technical-Vocational Education (TVE) tracks. The

Enhanced Basic Education Act of 2013 is the legal underpinning for curriculum reforms that are contextualized, learner-centered, and outcomes-based. Finally, the Department of Education (DepEd) has invited all teachers to use innovative ways to realize the different objectives of the program. However, despite the potential for PPBL to align national objectives with the corresponding approach, implementation on the ground, especially in public schools, has been erratic as a result of several factors, including, but not limited to, lack of training, resources, and unsynchronized models of implementation.

The Division of Batangas Province, Department of Education adopts this Republic Act and offers great privilege to young students or young minds who have the inevitable power of doing things with great courage and interest to enter the world of business. The students of the present generation look to become their own superiors and aim to create new products. The present education system offers a variety of options for young citizens, and the teachers have the responsibility to motivate young aspirants to become entrepreneurs.

Karimi et al. (2023) stated that Problem- and Project-Based Learning are approaches that focus on students and have their advantages. It includes allowing students to make decisions, find solutions, think critically, and play a significant role in facilitating instruction. It also explained the differences and similarities between how problem-based learning and project-based learning are frequently mixed and used together. In problem-based learning, students develop solutions for problems, while in project-based learning, students develop their concepts and accomplish a comprehensive project.

Though project-based and problem-based learning were used and endorsed for their potential to develop entrepreneurial skills, this has not been well researched for direct implication within the Philippine basic education system, especially among the Grade 10 TVE classes. Most studies hitherto have focused on either PBL or PjBL per se, largely neglecting to study the synergy of their integration.

With this, it is relevant to assess the effect of problem-based and project-based learning on the entrepreneurial skills of vocational education students as applied in the K-12 setting. Moreover, this study aimed to evaluate the perceptions of students on the effects of integrating problem-based and project-based learning in enhancing entrepreneurial skills among Grade 9 TVE students of Malvar School of Arts and Trade during S.Y. 2025-2026.

1.1 Background of the Study

Applying a similar concept in education, integrating PPBL must be based on learners' intended learning outcomes. The PPBL intended learning outcomes include deep-content learning, problem-solving ability, self-directed learning, and collaboration. In this study focuses on the integration of problem-based learning and project-based learning and its effect to critical thinking, creativity and innovation, teamwork and resilience which is based on the aim of Republic Act No. 10679 otherwise known as the “Youth Entrepreneurship Act,” an act promoting entrepreneurship and financial education among Filipino youth, hereby declared the state's policy to support the ongoing growth of young Filipinos whose aptitude and skill in the financial and entrepreneurship sectors will be fostered and refined through education and targeted training initiatives.

Moreover, in Section 2. The Declaration of Policy of Republic Act No. 10679 stated that the state will create, uphold, and facilitate a comprehensive, sufficient, and cohesive system of education and training to support and foster the development of young entrepreneurs across the country, as well as to instill an entrepreneurial spirit in our children.

The concept of the K-12 Curriculum Guide’s overarching goal is the holistic development of every Filipino learner with 21st-century skills who is adequately prepared for work, entrepreneurship, middle-level skills development, and higher education. The overarching goal of the K to 12 curriculum tells you that the teaching of Technology and Livelihood Education plays a very important role in the realization of the overall goal of the curriculum. Whether or not the K to 12 graduate is skilled and ready for work, entrepreneurship,

and middle skills development depends to a great extent on how effectively you taught Technology and Livelihood Education. Technology and Livelihood Education is geared towards the development of technological proficiency and is anchored on knowledge and information, entrepreneurial concepts, process and delivery, work values, and life skills. K to 12 Technology and Livelihood Education is built on adequate mastery of knowledge and information, skills and processes, acquisition of right work values and life skills; equips students with skills for lifelong learning; and is founded on cognitive, behavioral, or psychomotor and affective dimensions of human development. Technology and Livelihood Education, by its nature, is dominantly a skill subject, and so students must engage in an experiential, contextualized, and authentic teaching learning process. It is a subject where the students learn best by doing. It is integrative in approach. Technology and Livelihood Education exploratory courses focus on four basic common competencies: 1) use and maintenance of tools and equipment; 2) mensuration and calculation; 3) occupational health and safety procedures; and 4) preparation and interpretation of technical drawings. The competencies are all basic because they are competencies that students must acquire in order for them can do higher level competencies.

In a wider educational context, Maisaroh et al. (2019) stated that when compared to Bloom's taxonomy of the cognitive domain, PPBL appears to be effective in promoting students' learning at a higher cognitive level of application and evaluation, but not at the understanding level.

In relating PPBL to higher-order thinking skill components, several studies that are related to PPBL and critical thinking have resulted in positive findings. However, several studies also resulted in negative findings or no significant difference between the two comparison groups in investigating the effects of PPBL on critical thinking.

In the Problem-based and project-based approach, according to Kuppuswamy et.al. (2020), students solve an actual-world problem in a physical workspace. They learn concepts and principles through the process of problem solving, based on specific learning goals. Students integrate the new concepts and principles learned into existing knowledge structures by interpreting based on their previous knowledge and experiences. Skills competency learning in vocational high schools is designed to equip students with entrepreneurial knowledge through creative and entrepreneurial product subjects. Entrepreneurship learning in vocational schools is carried out through the implementation of the project-based learning model as an effort to prepare graduates who have the intention and readiness to become entrepreneurs. Teachers successfully engage learners of all ages by teaching multiple standards simultaneously through Problem-based and Project-based Learning. Students not only gained knowledge in traditional subjects through PPBL, but also had the opportunity to develop entrepreneurship abilities as they innovated in their projects.

The existing knowledge gaps concerning the link between PPBL and knowledge acquisition, critical thinking ability, and intrinsic motivation have called for further research, particularly in the area of engineering education in polytechnics. The need for more research to be done in the above-mentioned areas has also been supported by previous researchers. It has been acknowledged that there is room for more studies to be conducted in controlled experimental conditions, by using actual measures in assessing the effectiveness of PPBL in cultivating students' knowledge acquisition, critical thinking ability, creativity, innovation, and resiliency.

2. Methodology

This section presents the research design of the study, including the respondents, population, sampling technique, data gathering procedures, instrument formulation, and the establishment of the validity and reliability status of the instrument used to provide answers to the statement of the problem.

2.1 Research Design

The researcher employed an experimental research design, which is defined as a scientific approach for hypothesis testing by manipulating one or more variables and observing the response of another variable. The method of cause-and-effect relationships is established through a controlled process whereby the researcher adjusts the independent variable and then watches what happens to the dependent variable. Among the main components are the control and experimental groups, where the participants are assigned to a group of Grade 9 TVE learners at Malvar School of Arts and Trade.

2.2 Respondents of the Study

One group for the study consisted of forty-five (45) Grade 9 students who were in the Technical-Vocational Education (TVE) program. This single section was the target population, selected to give in-depth observations on the academic performance and learning experiences of TVE learners at the high school level. The group was deemed fit for the research as they had comparable teaching and learning conditions, thus allowing uniform data gathering and analysis. Their involvement offered the researchers opportunities to gauge the effects of the integration of problem-based and project-based learning on their entrepreneurial skills.

2.3 Population and Sampling Technique

This study was to assess the effect of the integration of problem-based and project-based learning on the entrepreneurial skills of Grade 9 TVE students at Malvar School of Arts and Trade.

For this study, the researcher used a purposive sampling technique to choose the respondents. The sampling method was chosen to allow the researcher to pick out the respondents possessing the traits that are most relevant to the research objectives. In this case, the Grade 9 TVE students were selected on the basis of their complete involvement in the Technical-Vocational Education program, which qualifies them to be the most appropriate group to give the data that are even related to the study's focus. The researcher assured that the respondents can provide well-informed insights and experiences, thus improving the validity and reliability of the data collected.

2.4 Data Gathering Procedures

The researcher designed this study to assess the effect of the integration of problem-based and project-based learning on the entrepreneurial skills of selected Grade 9 TVE students at Malvar School of Arts and Trade. To develop the research title, statement of the problems, and conceptualization of the research paradigm, the researcher consulted the methods of research professor and was given necessary advice for the initial research.

To gather the necessary data from the respondents, the researcher personally sought the permission of the Schools Division Superintendent (SDS) of the Division of Batangas Province, as well as the Public Schools District Supervisor (PSDS) and the School Head, to conduct this study in the school under their supervision.

The researcher then asked for the approval of the adviser of the Grade 9 TVE learners in the said school. After the approval, the researcher carried out a systematic procedure to test the success of Project-Based Problem-Based Learning (PPBL) in developing the entrepreneurial skills of Grade 9 students in the Technical and Vocational Education (TVE) field. The researcher started by incorporating PPBL strategies into a five-week lesson plan, where students participated in experiential and problem-solving-oriented learning activities associated with entrepreneurship.

After that, a pre-test and post-test were given for every lesson to assess the increase in students' knowledge and skills before and after the PPBL intervention. A group project was assigned to the students as a way of bringing their learning to life; a rubric was used for the evaluation of this project so that there would be an objective and extensive assessment of the performance. The researcher also gave out a questionnaire to the students in order to find out how they perceive the impact of PPBL on their entrepreneurial skills. Combining both quantitative and qualitative methods enabled the researcher to see the whole picture regarding how PPBL affects both the learning outcomes and the students' attitudes.

The pre-test and post-test scores, group project scores, and students' responses were tallied, tabulated, statistically treated, analyzed, and interpreted.

2.5 Research Instrument

In the conduct of the study, two methods were used in the research for evaluating the effectiveness of Project-Based Problem-Based Learning (PPBL) in the development of Grade 9 TVE students' entrepreneurial skills. The first part of the research instrument is a 5-week lesson plan, which was integrated with PPBL and served as the main teaching guide. One of the main entrepreneurial concepts was introduced each week: Product Concept, Product Life Cycle, Designing a New Product, Naming a Product, and Creating a Product Slogan. The PPBL principles were applied in the lessons to ensure that the learning was active, creative, and problem-solving oriented in real business scenarios.

The pre-test which is context-based was given before each lesson to find out about the existing knowledge of students and their starting skill level. Each pre-test consisted of twenty (20) items that were specifically designed for the entrepreneurial skills developed during the week. To illustrate, in Week 1 on the topic of Product Concept, there might be a question that evaluates students' ability to think critically about the choice of brand names in a real business case.

A post-test was followed which is also a context-based with the same format as the pre-test was administered after each lesson to assess students' development and the impact of the PPBL method on their entrepreneurial skills.

After the pre-test and post-test, students' group projects showing their practice through learning were assessed by means of a rubric. The rubric provides five performance levels: Exceptional (5), Very Good (4), Average (3), Needs Improvement (2), and Poor (1) for each entrepreneurial skill, which guarantees an objective and consistent evaluation of students' outputs.

Finally, a survey questionnaire was conducted in order to document students' perceived impact of the PPBL on their entrepreneurial skills. The instrument obtained students' insights, attitudes, and reflections on the ways the PPBL experience has affected their creativity, collaboration, critical thinking, and business understanding.

2.6 Statistical Treatment of Data

Quantitative analysis of data was used. The data collected were treated statistically using descriptive and inferential statistics such as mean, standard deviation, the Friedman test and the t-test of difference.

Mean. This statistic was used to assess the respondents' standing based on pre-test and post-test, as well as in the assessment of the level of student-respondents' entrepreneurial skills in project-based learning using a rubric and the perceived effects of problem-based and project-based learning on the entrepreneurial skills of Grade 9 TVE students.

Standard Deviation. This statistic was used to assess the respondents' standing based on pre-test and post-test, as well as in the assessment of the level of student-respondents' entrepreneurial skills in project-based learning using a rubric and the perceived effects of problem-based and project-based learning on the entrepreneurial skills of Grade 9 TVE students.

T-test of difference. This statistic was used to test the significant difference between pre-test and post-test scores, as well as the entrepreneurial skills of student-respondents using problem-based and project-based learning.

Friedman Test. This statistic was used to test the significant difference in the entrepreneurial skills of student-respondents when exposed to project-based learning.

3. Results and Discussion

This section presents and interprets the data collected through pre-tests and post-tests, a rubric, and a survey questionnaire by using generally accepted statistical tools and concepts. Primary sources of the data for this study came from pre-test and post-test scores, performance task scores, and answers in survey questionnaires given and distributed to assess the effect of the integration of problem-based and project-based learning on the entrepreneurial skills of Grade 9 TVE students at Malvar School of Arts and Trade for the S.Y. 2025-2026.

The following tables present the assessment of the students:

Table 1 shows the student-respondents' pre-test performance results on critical thinking, creativity and innovation, teamwork, and resilience. As presented in the table, students achieved a "Very Good" performance before the integration of problem-based and project-based learning.

The critical thinking evaluation showed students' skills reached strong levels through the 3.74 average score, which had a standard deviation of 0.89. The respondents achieved the same competence across all four pretest components, which gained "Very Good" ratings. Facione (2016) stated that students who develop critical thinking skills will use reflective decision-making and logical analysis skills, which the respondents demonstrated during their pretest assessment, and consider critical thinking a necessary skill to achieve effective reasoning.

Sulaiman et.al. (2024) stated that the critical ability of entrepreneurial skills for which the learners of Technical Vocational Education (TVE) are taught to analyze situations, solve problems, and make decisions among many choices in real-life work and business settings. In entrepreneurship, the learners are constantly bombarded with problems such as scarcity of resources, competitors, customers' demands, and unforeseen risks.

The students performed very good performance on creativity and innovation, with results through their overall mean score of 3.77, which had a standard deviation of 0.96. The results show that learners showed the capability to create original ideas and show innovative thinking, even in the integration of problem-based and project-based learning. The results showed that respondents had high creative potential, which displayed slight differences that standard deviation measurements could detect. This can be supported by Robinson (2020), who stated that creative skills should receive equal development with basic literacy and numerical skills because these skills represent the essential components of effective education. While Khaerunnisa et.al. (2024) revealed that creative problem-solving skills are considered important in preparing students to face the demands of an increasingly complex world of work, and showed that project-based Learning (PjBL) has a significant influence on increasing creative problem-solving abilities in students of entrepreneurship.

The assessment of teamwork showed an average score of 3.60 with a standard deviation of 0.99, which the assessors considered to be "Very Good," yet this score fell short of the scores for critical thinking and creativity assessment. The performance indicator showed a lower result than other indicators, but it remained within the range of acceptable performance standards.

The results demonstrate that students have the necessary skills to work together with their classmates, although their collaborative abilities show different levels of development. The Organization for Economic Co-operation and Development (2018) research shows that groups that work together through cooperative learning methods develop better social skills and experience positive group relationships, which leads to better educational performance. Collaborative competence is identified by the organization as a basic element

that students need to develop to succeed in 21st-century education. Teamwork skills are considered essential for personal, academic, and professional achievement according to Yan et.al. (2019). However, little is known about how some specific features of students and their educational development can affect their acquisition.

Table 1. Pre-Test Scores of the Student-Respondents

Indicators	Test	Mean	SD	Verbal Interpretation
Critical Thinking	Pretest1	3.80	0.92	Very good
	Pretest2	3.58	1.06	Very good
	Pretest3	3.73	1.10	Very good
	Pretest4	3.84	0.98	Very good
	Overall	**3.74**	**0.89**	**Very good**
Creativity and Innovation	Pretest1	3.78	1.11	Very good
	Pretest2	3.71	1.18	Very good
	Pretest3	3.67	1.00	Very good
	Pretest4	3.93	0.99	Very good
	Overall	**3.77**	**0.96**	**Very good**
Teamwork	Pretest1	3.69	1.08	Very good
	Pretest2	3.38	1.21	Very good
	Pretest3	3.58	1.03	Very good
	Pretest4	3.76	1.07	Very good
	Overall	**3.60**	**0.99**	**Very good**
Resilience	Pretest1	3.53	1.22	Very good
	Pretest2	3.36	1.07	Satisfactory
	Pretest3	3.51	1.18	Very good
	Pretest4	3.80	1.01	Very good
	Overall	**3.55**	**1.04**	**Very good**

Legend: *4.50 – 5.00 Exceptional*
3.50 – 4.49 Very good
2.50 – 3.49 Satisfactory
1.50 – 2.49 Needs improvement
1.00 – 1.49 Poor

The assessment of resilience showed an overall score of 3.55, with a standard deviation of 1.04, but the evaluators considered the score to be "Very Good." The pretest assessment showed one element to achieve "Satisfactory" status, which showed that students needed help because they struggled with academic challenges and setbacks. The standard deviation for this measurement shows a higher student resilience distribution because it has a higher value than all other assessment points. The evidence supports Duckworth's

(2016) argument that establishing perseverance with continuous effort leads to successful outcomes. The definition of resilience describes it as the ability to successfully adjust to challenging situations, which plays a vital role in student development. Students achieved their highest performance in creativity and innovation, but critical thinking showed slightly lower performance than that. The assessment results showed teamwork and resilience as two skills that students achieved at a good level. While Almeida (2017) stated that the potential for improving the learning process can be enhanced by attractive, motivating, and effective media, which create favorable situations between students and teachers.

Table 2. Post-Test Scores of The Student-Respondents

Indicators	Test	Mean	SD	Verbal Interpretation
Critical Thinking	Posttest1	4.47	0.59	Very good
	Posttest2	4.27	0.75	Very good
	Posttest3	4.33	0.80	Very good
	Posttest4	4.51	0.73	Exceptional
	Overall	**4.39**	**0.58**	**Very good**
Creativity and Innovation	Posttest1	4.40	0.75	Very good
	Posttest2	4.27	0.99	Very good
	Posttest3	4.29	0.73	Very good
	Posttest4	4.42	0.87	Very good
	Overall	**4.34**	**0.68**	**Very good**
Teamwork	Posttest1	4.24	0.96	Very good
	Posttest2	3.98	0.94	Very good
	Posttest3	4.16	0.93	Very good
	Posttest4	4.29	0.76	Very good
	Overall	**4.17**	**0.72**	**Very good**
Resilience	Posttest1	4.20	0.89	Very good
	Posttest2	3.89	0.88	Very good
	Posttest3	4.16	0.90	Very good
	Posttest4	4.36	0.68	Very good
	Overall	**4.15**	**0.70**	**Very good**

Legend: *4.50 – 5.00 Exceptional*
3.50 – 4.49 Very good
2.50 – 3.49 Satisfactory
1.50 – 2.49 Needs improvement
1.00 – 1.49 Poor

The overall mean score of 4.39 with a standard deviation of 0.58 in critical thinking was assessed as "Very Good," while posttest 4 achieved a mean score of 4.51, which evaluators classified as "Exceptional."

The standard deviation demonstrates high response consistency among students because it remains at a high level. The result of student responses was shown as students developed skills in analyzing information and evaluating sound decisions, and making reasoned judgments as a result of the integration of problem-based learning. This also showed that the researcher identifies critical thinking as a fundamental skill required for academic and real-world problem-solving.

Afnia et.al. (2021) cited that students with visual, auditory, and kinesthetic learning styles had different critical thinking skills. Students with visual learning styles can fulfill the aspects of interpretation, analysis, evaluation, explanation, and self-regulation. The inference aspect cannot be fulfilled by visual students. Students with auditory learning styles can fulfill the aspects of interpretation, analysis, evaluation, and explanation. The aspects of inference and self-regulation have not been fulfilled by auditory students. Students with kinesthetic learning styles can fulfill the aspects of interpretation, analysis, and evaluation, and argued that learners who acquire strong critical thinking skills will develop the ability to assess evidence and create informed choices, which their post-test results show as evident competencies. Asrowi (2023) explained that the majority of students demonstrate a low level of critical thinking skills within the hybrid learning context, indicating the need for improvement; secondly, various factors that influence these skills were identified. These outcomes emphasize the challenges associated with acquiring 21st-century skills and emphasize the necessity for collaborative efforts.

The creativity and innovation assessment received very good ratings, which demonstrated that students developed their ability to create new ideas, expand their knowledge, and create new solutions. The moderate standard deviation shows that all participants achieved similar progress during the study. The overall mean score of 4.34 with a standard deviation of 0.68 shows that creativity and innovation assessment results fall within the "Very Good" range as a result of the integration of problem-based learning. According to Granieri et al. (2017), creativity serves as a vital component of successful educational systems, which helps students build skills to navigate challenging situations. The creativity as an essential skill that enables students to succeed in innovation-based economies. The high post-test scores indicate that the instructional approach likely fostered imaginative thinking and idea development. Bacigalupo et al. (2016) stated that Innovation is seen as an internal driver; innovation relates to an entrepreneurial mindset; thus, the development of new products or entry to new markets is the result of entrepreneurship. Entrepreneurship education is an important way for entrepreneurs to acquire resources, enhance innovative ability and innovative personality, and build multi-level learning channels for entrepreneurs by integrating various knowledge and value systems. The creativity as an essential skill which enables students to succeed in innovation-based economies. The high post-test scores indicate that the instructional approach likely fostered imaginative thinking and idea development.

The scores that fell short of critical thinking and creativity assessment results still showed students a positive effect of the integration of problem-based learning. The findings imply that students effectively communicated, cooperated, and contributed within group settings. The students achieved an overall mean score of 4.17 with a standard deviation of 0.72, which is interpreted as "Very Good." The reduced variability compared to many baseline studies suggests improved group cohesion and shared responsibility. Structured cooperative learning provides benefits that improve both social skills and academic performance. Collaborative skills are essential abilities that people need for solving problems together while engaging in social activities.

The overall score of resilience assessment reached 4.15 with a standard deviation of 0.70, which is interpreted as "Very Good." All indicators received a very good rating of integration of problem-based learning because they showed students had developed better skills to handle adversity through their improved ability to endure and adjust to difficulties. The respondents showed more stable resilience levels because their pre-intervention findings displayed lower standard deviation results. The results of this study match Duckworth's (2016) research, which showed that success depends on people who persevere through their work. He defined resilience as the capacity to adapt positively in the face of adversity, which he considered

essential for academic and personal development. While Sullivan & Flanders (2021) showed that PrBL and PBL environments support students in building resilience through their experience with guided failure cycles and self-directed learning methods.

The post-test results show strong performance across all four assessment areas, with critical thinking achieving the highest average score and one outstanding evaluation. The assessment results showed that students achieved high levels of proficiency in creativity and innovation, while teamwork and resilience achieved substantial competence through the integration of problem-based learning. The students demonstrated both skill development improvement and consistent learning progress according to their assessment results, which showed high average scores and low standard deviation results. The educational research findings support current educational models, which require students to develop cognitive abilities, creative skills, social competencies, and emotional intelligence through their learning experiences.

Additionally, table 3 presents the level of student-respondents' entrepreneurial skills in project-based learning as measured through a rubric across four weeks of implementation. The results show consistently high ratings across all four skill domains, which include critical thinking, creativity and innovation, teamwork, and resilience. The progressive weekly scores indicate sustained and improving performance as students engaged more deeply in project-based tasks.

The weekly mean for critical thinking showed an upward trend through the first three weeks which started at 4.00 "Very Good" for both Week 1 and Week 2 and reached 4.67 with a verbal interpretation of Exceptional in Week 3 and then fell to 4.22 with a verbal interpretation of "Very Good" in Week 4 with an overall average of 4.22 and SD of 0.34 that people considered to be "Very Good." The peak in Week 3 shows that students reached advanced analytical and evaluative skills through their increased project task involvement. The low overall standard deviation shows that students maintained steady performance throughout the four weeks. This supports the framework of the Buck Institute for Education, which asserts that Project-Based Learning enables students to develop advanced thinking abilities through their participation in real-world problem-solving activities. John Dewey stated that experiential learning enables students to develop reflective thinking, which leads to deeper understanding. These two things show different ways of critical thinking, which show both procedural development and practical abilities. Paiva et.al. (2021) present how problem-based learning methodology (PBL) and project-based learning can be an approach to promote critical thinking in higher education students within the context of entrepreneurship education. PBL was applied to promote intergenerational collaboration to leverage the creation of their own business.

The study results show that creativity and innovation reached an overall mean of 4.42 and the SD of 0.31, which respondents considered "Very Good." The Week 3 data show an upward trend because students developed new ideas through their work on projects. The standard deviation remains low, which proves that students maintain their learning progress throughout their educational journey. This can be supported by the Organization for Economic Co-operation and Development (2018), which states that creativity grows best when students have control over their studies and work on real-world projects, which represent essential components of project-based learning. It claimed that students develop their creative abilities when teachers create educational environments that permit students to investigate and test their ideas through project-based learning. Moreover, as the main body of learning in entrepreneurship education, according to Kassean et al. (2016), students should consider their obvious campus characteristics. In student entrepreneurship, many entrepreneurial projects are based on innovative technology transformation and creativity. Innovation is the driving force for the development of entrepreneurial projects.

The research obtained strong results about teamwork because all four weeks of assessment reached the Exceptional rating, while participants achieved 4.69 average score which had standard deviation of 0.27. The highest score during Week 3 reached 4.89, which showed that students worked together extremely well. The continuous high ratings indicate that project-based learning created a strong environment that promoted teamwork between students while they worked together to achieve their common objectives. The research shows that structured collaborative learning methods improve both personal skills and team performance. The

students in project-based learning work together, which helps them develop teamwork skills because they need to work together to finish their challenging assignments. According to Johnson (2023), team-based projects in technical and vocational education create stronger peer relationships which help students resolve conflicts and coordinate their tasks to achieve effective team performance.

Table 3. Level of Entrepreneurial Skills in Project-based learning using a Rubric.

Indicators	Administration	Mean	SD	Verbal Interpretation
Critical Thinking	Week1	4.00	0.71	Very Good
	Week2	4.00	0.50	Very Good
	Week3	4.67	0.50	Exceptional
	Week4	4.22	0.44	Very Good
	Overall	**4.22**	**0.34**	**Very Good**
Creativity and Innovation	Week1	4.33	0.71	Very Good
	Week2	4.11	0.60	Very Good
	Week3	4.78	0.44	Exceptional
	Week4	4.44	0.53	Very Good
	Overall	**4.42**	**0.31**	**Very Good**
Teamwork	Week1	4.78	0.44	Exceptional
	Week2	4.56	0.53	Exceptional
	Week3	4.89	0.33	Exceptional
	Week4	4.56	0.53	Exceptional
	Overall	**4.69**	**0.27**	**Exceptional**
Resilience	Week1	4.78	0.44	Exceptional
	Week2	4.56	0.53	Exceptional
	Week3	5.00	0.00	Exceptional
	Week4	4.78	0.44	Exceptional
	Overall	**4.78**	**0.26**	**Exceptional**

Legend: *4.50 – 5.00 Exceptional*
3.50 – 4.49 Very good
2.50 – 3.49 Satisfactory
1.50 – 2.49 Needs improvement
1.00 – 1.49 Poor

The overall average score for resilience reached 4.78 with a standard deviation of 0.26, while all weeks received Exceptional ratings, and Week 3 reached a perfect score of 5.00. The students maintained their ability to continue working during the entire project period, which lasted from start to end. The participants showed consistent resilience throughout the entire project, which created a very low standard deviation. Ocampo & Kim (2023) discovered that when students think about their project workflow setbacks and

problems to be solved, they develop better adaptive resilience, while their tendency to avoid challenges decreases.

Table 4. Level of Effectiveness of Problem-Based and Project-Based Learning on Critical Thinking

Indicators	Mean	SD	Verbal Interpretation
Problem-based and Project-based learning……			
1…greatly enhances my skill in analyzing entrepreneurial cases and exploring possibilities of solutions.	3.42	0.66	Effective
2…improves my ability to judge diverse business ideas and strategies before deciding.	3.38	0.76	Effective
3…boosts my critical thinking skills when confronted with actual challenges.	3.51	0.73	Very Effective
4…consider diverse angles before solving any business-related problem.	3.51	0.80	Very Effective
5…develop my ability to make sound judgments and decisions in doing entrepreneurial activities.	3.51	0.75	Very Effective
Overall	**3.47**	**0.52**	**Effective**

Legend: *3.50 – 4.00 Very Effective*
2.50 – 3.49 Effective
1.50 – 2.49 Moderately Effective
1.00 – 1.49 Not Effective

Moreover, this study examines how Problem-Based and Project-Based Learning methods affect Grade 9 TVE students' entrepreneurial abilities through their assessment results, which include four assessment areas. The findings reveal that the instructional approaches were generally effective, with three domains rated "Very Effective" and one domain, critical thinking, interpreted as "Effective." The standard deviations, which remained low throughout all measured indicators, demonstrated that students provided consistent answers to all questions. Doly's (2024) research about project-based learning (PBL) shows evidence that proves your assertion about its benefits for critical thinking, collaboration and innovation, resilience, and capacity development. The studies demonstrate that PBL requires students to solve actual problems, which results in enhanced development of their advanced thinking skills and communication abilities.

The overall critical thinking performance reached a mean score of 3.47 with a standard deviation of 0.52, which classified this performance level as "Effective." The three indicators received "Very Effective" ratings with scores of 3.51, while two indicators achieved "Effective" ratings through their scores of 3.42 and 3.38. The research findings show that students who learned through Problem-Based and Project-Based Learning methods obtained knowledge, but needed longer periods of instruction to master advanced thinking abilities. Critical thinking is widely recognized as a core outcome of inquiry-based instruction.

The research conducted by Febrianti et al. (2022) demonstrates that students who participate in real-world learning activities that focus on solving actual problems become better critical thinkers. The implementation of project-based and problem-based learning approaches enables students to enhance their critical thinking abilities during creative product and entrepreneurship courses when they participate in authentic problem-solving activities that follow organized project work.

The research conducted by Maseno (2022) demonstrates that Project-Based Learning improves critical

thinking abilities and problem-solving skills, and cognitive reasoning abilities in students. The researchers at Maseno University discovered that the Project-Based Learning methodology helps secondary students develop critical thinking abilities, which are essential for analyzing complex learning tasks.

The study conducted by Lopez et al. (2023) demonstrated that Problem-based and Project-based learning improve critical thinking abilities, but their impact becomes stronger when students handle demanding real-life situations over an extended time. The researchers found that "student exposure to iterative problem cycles significantly predicts growth in critical thinking within science and technology, engineering, mathematics, and entrepreneurial contexts". The dedicated practice of this skill allows users to develop their ability to master this specific skill.

Table 5. Level of Effectiveness of Problem-Based and Project-Based Learning on Creativity and Innovation

Indicators	Mean	SD	Verbal Interpretation
Problem-based and Project-based learning……			
1…motivates me to think about new and original ideas related to any entrepreneurial activity.	3.56	0.66	Very Effective
2…possess the skill to devise creative solutions to real-world business problems. also, moves me towards innovative strategies for developing business projects or outputs.	3.58	0.58	Very Effective
3…develop my skills to actually convert ideas into tangible and useful entrepreneurial products or services.	3.56	0.66	Very Effective
4…building my confidence to experiment with various vehicles to achieve innovative outcomes.	3.53	0.59	Very Effective
5…enhances my ability to work well with my peers on any entrepreneurial task.	3.62	0.58	Very Effective
Overall	**3.57**	**0.50**	**Very Effective**

Legend: *3.50 – 4.00 Very Effective*
2.50 – 3.49 Effective
1.50 – 2.49 Moderately Effective
1.00 – 1.49 Not Effective

Moreover, in Table 5, the overall creative and innovative performance reached a mean score of 3.57 with a standard deviation of 0.50, which classified this performance level as "Very Effective."

The combined approach of Problem-based and Project-based learning enabled students to produce ideas and investigate different options, which led to successful creation of innovative results according to the study results. The different ways people responded to questions about their innovation output showed that they produced stable results during their responses.

The research conducted by Sari et al. (2022) demonstrates that project-based and problem-based learning methods help students develop their creativity and innovative abilities. Rahman et al. (2023) reported that vocational students achieve better learning results and increased engagement when they study in constructivist environments, which include Problem-based and Project-based learning, because these methods

promote better exploration and reflection and idea development. The research demonstrates that the combination of Problem-based and Project-based learning creates educational experiences that lead to ongoing development of creative and innovative abilities.

Table 6. Level of Effectiveness of Problem-Based and Project-Based Learning on Teamwork

Indicators	Mean	SD	Verbal Interpretation
Problem-based and Project-based learning……			
1…enhances my communication skills when working with team partners.	3.58	0.62	Very Effective
2…empower me with a sense of responsibility and accountability in group projects.	3.60	0.50	Very Effective
3…helps me develop a sense of responsibility and accountability in group projects.	3.58	0.54	Very Effective
4…strengthens my ability to resolve conflicts and make collective decisions within a team.	3.56	0.59	Very Effective
5…helps me practice cooperation and mutual support among group members in achieving entrepreneurial goals.	3.60	0.54	Very Effective
Overall	**3.58**	**0.43**	**Very Effective**

Legend: *3.50 – 4.00 Very Effective*
2.50 – 3.49 Effective
1.50 – 2.49 Moderately Effective
1.00 – 1.49 Not Effective

In Table 6, the Teamwork assessment results showed an average score of 3.58 with a standard deviation of 0.43, which the researchers classified as "Very Effective."

The results demonstrate that Problem-Based Learning and Project-Based Learning methods, which involve collaborative activities, successfully developed students' teamwork skills and interactive abilities, and their task-sharing capabilities. The low standard deviation further indicates strong agreement among respondents regarding the effectiveness of these approaches in building collaborative skills. The research conducted by Johnson et.al. (2017) shows that PBL environments enable students to work together while sharing responsibility and doing team evaluations, which lead to improved results in collaborative problem-solving.

The project-based environments of education, which Martínez and Torres (2022) studied showed that they fostered teamwork because students worked on real projects together with their team members through a process of continuous assessment. The studies demonstrate that experiential and collaborative learning frameworks develop teamwork skills that students need for success in both modern educational and professional environments.

Table 7. Level of Effectiveness of Problem-Based and Project-Based Learning on Resilience

Indicators	Mean	SD	Verbal Interpretation
Problem-based and Project-based learning……			
1…motivates to stick to challenges, especially in entrepreneurship.	3.67	0.52	Very Effective
2…revolves around making courtesy quickly from mistakes and failures during project or problem-solving activities.	3.69	0.47	Very Effective
3…persist in completing entrepreneurial projects despite having a hard time.	3.53	0.59	Very Effective
4…builds the confidence to cope with uncertainties and risk factors in business-related activities.	3.64	0.53	Very Effective
5…spreads positive adaptation to change and surprises associated with group tasks or projects.	3.62	0.58	Very Effective
Overall	**3.63**	**0.44**	**Very Effective**

Legend: *3.50 – 4.00 Very Effective*
2.50 – 3.49 Effective
1.50 – 2.49 Moderately Effective
1.00 – 1.49 Not Effective

In the table 7, the Resilience assessment results showed an overall mean score of 3.63 with a standard deviation of 0.44 which the evaluators classified as "Very Effective." All indicators received very good ratings because students perceived Problem-based and Project-based learning as effective methods for improving their perseverance and adaptability and ability to face challenges. Entrepreneurial education often involves dealing with complex, open-ended tasks which can cultivate resilience over time. Masten (2018) states that people develop resilience through adaptive systems which become more powerful when they face controllable challenges inside environments that provide them with help. Cassidy (2016) discovered that students develop academic resilience when they acquire the chance to succeed through organized learning methods that emphasize student involvement. The study showed that people develop perseverance through their participation in challenging tasks that present them with meaningful work. Resilience develops better when students work in environments that support them and help them learn to face their challenges.

Table 8 t-test results demonstrate how the student respondents showed different test results in four entrepreneurial skill areas, which included critical thinking and creativity and innovation, teamwork, and resilience. The results show that all four areas showed statistically improved entrepreneurial skills because the p-values reached less than 001. The higher post-test score emphasized actual student growth in entrepreneurial skills as post-test evidence. The pre-test critical thinking score of 3.74 and a standard deviation of 0.89 raised to 4.39 and a standard deviation of 0.58 during the post-test assessment. The calculated t-value of -9.15 with 44 degrees of freedom and a p-value of $< .001$ demonstrates an extremely significant progress. The mean difference of -0.656 shows that participants increased their performance level. Students who achieved the post-test assessment but showed lower standard deviation scores had better performance results according to the assessment criteria. Facione (2016) showed that students develop critical thinking skills through two educational methods, which include inquiry-based and problem-centered

instruction.

Table 8. Test of Difference Between the Pre-Test and Post-Test Scores

Entrepreneurial Skills	Pretest		Posttest		Mean Diff	t	df	p
	M	SD	M	SD				
Critical Thinking	3.74	0.89	4.39	0.58	-0.656	-9.15	44	< .001
Creativity and Innovation	3.77	0.96	4.34	0.68	-0.572	-8.57	44	< .001
Teamwork	3.60	0.99	4.17	0.72	-0.567	-7.54	44	< .001
Resilience	3.55	1.04	4.15	0.70	-0.6	-7.61	44	< .001

Legend: *p<0.05, significant,*
p>0.05, not significant.

The mean of creativity and innovation score increased from 3.77 (SD = 0.96) to 4.34 (SD = 0.68), with the t-value of -8.57 showing that p < .001 resulted in a statistically significant development. The mean difference of -0.572 shows that students made significant progress in becoming better at producing fresh concepts and finding new solutions. Bacigalupo et al. (2016) stated that Innovation is seen as an internal driver; innovation relates to an entrepreneurial mindset; thus, the development of new products or entry to new markets is the result of entrepreneurship.

The pre-test results for teamwork showed an average score of 3.60 with a standard deviation of 0.99, which increased to a post-test score of 4.17 with a standard deviation of 0.72. The two assessments show a significant difference because the t-value reached -7.54, while the p-value remained below .001. The students developed better collaborative and interpersonal skills because they showed a mean score improvement of -0.567. The post-test results show a lower standard deviation, which indicates that groups experienced better cohesion and shared responsibility during their work. The research finding demonstrates that structured cooperative learning strategies improve both teamwork skills and academic performance (Red, 2021).

Students exhibited enhanced resilience through their pre-test score of 3.55 with a standard deviation of 1.04 and their post-test score of 4.15 with a standard deviation of 0.70. The t-value of -7.61 and p < .001 confirm a statistically significant difference. The mean difference of -0.600 shows that students made outstanding improvements in their ability to cope with difficult situations. The intervention results in a standard deviation reduction, which indicates that participants developed more consistent resilience capabilities. Duckworth (2016) demonstrated that guided experiences can develop perseverance, while he identified resilience as a skill that people can develop through learning environments that provide support. Khaerunnisa et.al. (2024) study that problem-solving skills and project-based learning are considered important in preparing students to face the demands of an increasingly complex world of work. It was shown that project-based Learning (PjBL) has a significant influence on increasing creative problem-solving abilities in students of entrepreneurship.

The result shows that all four entrepreneurial skills demonstrate a statistically significant difference between the pre-test and post-test scores. The instructional intervention produced strong evidence that it improved students' critical thinking, creativity and innovation skills, teamwork abilities, and resilience in the integration of project-based and problem-based learning because the p-values remained below .001. The results demonstrate that intentional educational strategies enable schools to develop entrepreneurial competencies in students.

Table 9. Test of Difference in the Entrepreneurial Skills of Student-Respondents when exposed to Project-based Learning

Entrepreneurial Skills	Friedman		
	χ^2	df	p
Critical Thinking	9.1	3	0.028
Creativity and Innovation	6.42	3	0.093
Teamwork	3.86	3	0.277
Resilience	6	3	0.112

Legend: $p<0.05$, significant,
$p>0.05$, not significant.

The Friedman test results in Table 5 enable researchers to determine whether student respondents showed different entrepreneurial skills after experiencing Project-Based Learning for multiple weeks. The researcher used the Friedman test, which serves as a non-parametric alternative to repeated-measures ANOVA, to assess whether four time points produced statistically significant changes. The study results show that critical thinking was the only skill that proved to show actual statistical differences, while all other skills maintained their existing levels throughout the entire study period.

The critical thinking assessment shows that students achieved a statistically significant difference between their two assessment periods because their chi-square result reached 9.1 with three degrees of freedom and a 0.028 p-value. The four-week PBL program implementation led to major improvements in students' critical thinking skills. The result shows that ongoing project-based tasks development enables students to develop their skills in analytical reasoning and evaluative assessment. The Buck Institute for Education (2018) framework supports this finding because it demonstrates that continuous research and authentic problem-based learning activities develop higher-order thinking abilities. It also concluded that learners develop their ability to think reflectively through experiential learning when they participate in real-world problem-solving activities. For Mohammad et.al (2024), critical thinking positively influenced creativity, measured as the total number of unique product designs. Creativity (unique product designs) also positively mediated the link between critical thinking and performance.

The results for creativity and innovation showed a chi-square value of 6.42 with three degrees of freedom and a p-value of 0.093, which failed to meet the 0.05 level of statistical significance. The statistical test shows that week-to-week changes in creative performance between two weeks of testing exceeded their essential threshold for assessment because they failed to reach the required levels for determination of significance.

Moreover, the students demonstrated high creative performance throughout their learning process because they already possessed strong creative abilities at the start of their training program. To support this, the Organization for Economic Co-operation and Development (2018) states that creativity develops through time in environments that support both independent work and creative discovery, but short-term performance changes fail to show an actual statistical difference when initial performance levels are high. The Buck Institute for Education (2018) framework supports this finding because it demonstrates that continuous research and authentic problem-based learning activities develop higher-order thinking abilities. It also concluded that learners develop their ability to think reflectively through experiential learning when they participate in real-world problems.

The teamwork assessment produced a chi-square result of 3.86 with three degrees of freedom and a p-value of 0.277, which showed no different results between the four testing periods. The students maintained their high ability to work with others during the entire PBL process without showing different performance levels. The previous performance results showed exceptional results, which created a situation where statistical testing showed no significant results. Rodriguez (2018) stated that student attitudes towards

teamwork skills and specific student characteristics, such as gender, academic experience, or academic performance. Thus, today, according to Yan et.al. (2019) most higher education institutions highlight the necessity of including both hard and soft skills in their syllabus to meet the required personal, academic, and professional demands for a successful career.

Resilience test results showed a chi-square outcome of 6.00 with three degrees of freedom and a p-value of 0.112, but this result did not show any statistical significance. The Friedman test implies that there is no substantial variation on result which occurred during the weekly assessment of resilience because the weekly assessment results showed high resilience across all weeks. The implementation period showed that resilience remained constant throughout the period instead of showing gradual development. Duckworth (2016) explains that people build their resilience through continuous work on difficult activities, which leads to their ability to develop perseverance as a permanent character trait that does not change during brief intervals. Furthermore, according to the Global Entrepreneurship Index (2019), the importance of entrepreneurship is a dynamic process of creating additional wealth by providing valuable products or services. The product or service may or may not be new or unique, but the value must somehow be imbued by the entrepreneur through receiving and locating the necessary skills and resources.

4. Conclusion and Recommendations

Based on the results of the study, the following conclusions have been drawn: 1. The hypothesis being posited is not supported by the result of the study; therefore, there is a significant difference between the pre-test and post-test scores of student-respondents on critical thinking, creativity and innovation, teamwork, and resilience. 2. The hypothesis being posited has been supported by the results of the study. Therefore, it has been concluded that there is no significant difference between the entrepreneurial skills of student-respondents exposed to project-based learning.

From the conclusion drawn, the following are the researchers' recommendations.

Teachers may provide early diagnostic activities to identify areas of relative weakness, such as resilience and critical thinking, and design targeted interventions that help students strengthen these skills before engaging in full project-based activities.

Educators may implement Problem-Based Learning and Project-Based Learning methods throughout the entire curriculum to sustain and enhance students' entrepreneurial competencies.

Teachers may create project-based and problem-based activities that start with easy tasks and build toward difficult tasks that relate to real-life situations, which will help students create critical thinking skills, creativity skills, teamwork abilities, and resilience skills throughout several weeks.

Students may be encouraged to extend learning periods and multiple practice sessions to master critical thinking skills, while educators may use structured real-world work projects to promote creativity, teamwork, and resilience development.

Schools may implement a systematic framework for repetitive project-based and problem-based activities because continuous practice throughout extended periods results in substantial development of critical thinking abilities, creative skills, and collaborative abilities, and resilience.

Project-based and problem-based assignments may include analytical and evaluative methods, which curriculum planners should prioritize because these skills showed maximum improvement through extended PBL practice, while educators must sustain the development of high-level competencies, including creativity and teamwork.

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