

Developing a Project-Based Learning Manual for Teachers in Industrial Arts to Enhance Learners' Innovation Skills

*Ram Nicole B. Caguin, Jan Paulo P. Mendoza, Kristine R. Pascual, Catrisha Cassandra T. Tienzo, Joseline M. Santos, and Aileen H. Abelgos

Bulacan State University, College of Professional Teacher Education, Philippines

*Corresponding Author

DOI: <https://doi.org/10.47772/IJRISS.2026.100400517>

Received: 18 April 2026; Accepted: 23 April 2026; Published: 16 May 2026

ABSTRACT

This study developed and evaluated a Project-Based Learning (PBL) Manual tailored for Grade 8 Industrial Arts teachers in selected Technical-Vocational and Trade High Schools under the Schools Division of Bulacan. Employing a descriptive-developmental design, the research systematically gathered quantitative data to ensure the manual's validity and reliability. Grounded in Gold Standard PBL principles and aligned with the Department of Education's Learning Resource Management and Development System (LRMDS) guidelines. Findings revealed persistent challenges among teachers, including limited resources, constrained instructional time, and reliance on traditional pedagogical approaches. Expert evaluations by master teachers and Industrial Arts educators affirmed the manual's high quality in terms of content, format, presentation, and accuracy. Teachers expressed strong acceptance of the manual, recognizing its relevance and potential to foster creativity, collaboration, and problem-solving skills. By bridging curriculum requirements with authentic, hands-on project tasks, the manual aims to enhance learners' innovation competencies and prepare them for real-world applications. The study concludes that the developed manual is an effective instructional tool for advancing innovation and 21st-century skills in Industrial Arts education.

Keywords: Project-Based Learning (PBL); Industrial Arts; Innovation Skills; LRMDS; Technology and Livelihood Education (TLE); Gold Standard PBL; Instructional Manual; Grade 8 Education; Teacher Evaluation

INTRODUCTION

Background of the Study

In the status quo, it is evident that there is a shift of teaching styles amongst educators around the world – in this context, the use of Project-Based Learning approach inside the classroom are creating tides on how a particular lesson is being delivered to the students. PBL is a dynamic instructional framework that focuses on real-world, meaningful problems and queries, analyzed through sustained collaboration in able to create an authentic output or product that aims to tangibly respond to the problems presented at the beginning of the learning process (Markula, 2022).

For further contextualization, the Philippines education system continuously patronize Outcomes-Based Education (OBE) as the primary approach in learning and teaching, including the subject Technology and Livelihood Education. OBE is an educational approach where the goal of the learner is to achieve the standards and outputs set at the beginning of the academic year (Genelza, 2022), meanwhile, PBL focuses on the process and the continuous development of the outputs created by the student themselves. This comparison shows that OBE highlights the end product while PBL puts premium on the process of attaining the goal – quite a contrast, but when integrated with one another, it can create a process that is both seamless and centered on the students authentic learning.

Highlighting, that one of the significant components of the TVL track is the Technology and Livelihood Education (TLE) program, which includes various disciplines, such as Home Economics, Agri-Fishery Arts, Information and Communication Technology (ICT), and Industrial Arts. The inclusion of Industrial Arts in secondary education is intended to cultivate technical literacy, innovation, and creativity—skills that are vital in addressing local and global economic demands (Castillo & Dela Cruz, 2020; Dela Peña, 2021).

However, reaching such goal cannot happen overnight, considering that there is still a long list of problems and gaps exists on the way which may hinder the effective merging and implementation of these frameworks. It includes the persistence of traditional approach of teaching, where, instead of project-construction and inquiry assessment, the teachers rely heavily on lecture due to the problems identified in the study. Regardless, educators must first clearly define program-level and course-level outcomes, then design projects that provide authentic opportunities for students to demonstrate those outcomes—essentially backward design as advocated in OBE (Macayan, 2021). Teachers then must scaffold student inquiry, guide reflection, manage project milestones, and embed formative assessment—key features of high-quality PBL (Markula, 2022).

Additionally, if we were to look on the current status and overall quality of education in the country, it is evident that several challenges still persist despite progressive reforms, recurring concern is the gap between curriculum design and classroom practice. Many teachers rely on conventional, lecture-based instruction rather than hands-on, project-oriented learning. The limited incorporation of innovative pedagogies, such as Project-Based Learning (PBL), frequently results in student disengagement and reduced motivation (Corpuz & Salandanan, 2018; Larmer & Mergendoller, 2021). Furthermore, the absence of updated, context-appropriate teaching manuals hampers effective curriculum delivery (Garcia, 2020). Moreover, the lack of adequate learning resources and facilities, financial constraints and insufficient instructional time magnifies the existing problem.

Research Problem

This study investigated on three crucial issues that leads to the development of the proposed manual for teachers in Industrial Arts. Firstly, the study explored the different problems encountered by Industrial Arts teachers from technical vocational and trade schools as they deliver their lessons to the students. According to the General Shaping Paper – TLE (DepEd, 2023), while the curriculum strongly advocates for practical, student-centered approaches, many teachers still depend on traditional lecture-based methods, which can limit student engagement and the development of practical skills. This underscores a major concern—the curriculum-practice gap—where policy expectations are not fully realized in classroom realities. For example, TLE classes in the Philippines are most likely to be a lecture session due to the lack of resources, time constraint, and the pressure to finish a particular competency in a very short timeline.

Secondly, the researchers looked into the curriculum and competencies designed by the Department of Education for Industrial Arts specifically catered to Grade 8 students. This is to ensure that the developed manual is aligned with the standards and expectations of DepEd which would serve as the implementing body once the manual was approved. In this study, it is then underscored that the MATATAG K–10 Curriculum: EPP/TLE (DepEd, 2023) provides the updated learning competencies and content standards for Grades 4–10. It outlines the progression of skills from exploratory learning in the lower grades to specialized competencies in higher levels, including Industrial Arts. This curriculum framework emphasizes technical proficiency, creativity, and practical application, aligning well with the experiential learning approach. However, the lack of adequate instructional resources and project-based manuals often hinders teachers from effectively implementing hands-on learning. Hence, the curriculum itself supports the rationale for this study—developing a structured manual that bridges theoretical design and classroom practice.

Thirdly, the study tested the perceived acceptability of the validated manual amongst Industrial Arts teachers, considering that they would be the embodiment of the contents of the manual in real-world classroom setting. It is necessary for the researchers to gauge whether or not the teachers who are going to use the manual can relate, and use the manual in their classroom. This assessed they are not just their capabilities to respond to the dynamics of the current trends in the education sector but also to evaluate the feasibility of the activities provided in the material. Supported by the Indian PBL study notes that implementation requires teacher

training, resources, and a shift in mindset: “Driving questions, student voice & choice ... may be more challenging to implement.” (Markula & Aksela, 2022) Thus, for TLE/Industrial Arts, the challenge is not only getting students engaged, but also equipping teachers and infrastructure to adopt student-centered, project-oriented pedagogy. To further contextualize this part, the researchers, due to the lack of time, made the implementation of the manual optional for the teachers giving them the time to further study the contents of the teaching resource; hence this paper also suggests that future researchers shall pursue a full implementation of the manual to assess its effectivity in fuller scale.

REVIEW OF RELATED LITERATURE

This section details the synthesis of the related literature and studies that served as the foundation and support of this study.

The reviewed literature consistently emphasizes the transformative potential of Project-Based Learning (PBL) as a constructivist pedagogy that fosters creativity, collaboration, and innovation. Theoretical contributions from Markula (2022) and Thornhill-Miller et al. (2023) highlight how PBL shifts learners from passive recipients to active constructors of knowledge, thereby cultivating essential twenty-first century skills. Global frameworks, such as those advanced by UNESCO (2016), OECD (2019), and the World Economic Forum (2020), further underscore the importance of integrating skills-based and innovation-driven approaches into education to prepare learners for the demands of the Fourth Industrial Revolution. Within the Philippine context, scholars such as Macayan (2021) and Quinto (2020) argue that Outcomes-Based Education (OBE) provides a strong foundation for performance-driven learning but requires authentic pedagogical strategies to be fully realized. Collectively, the literature suggests that PBL and OBE are complementary frameworks: PBL provides the authentic tasks and processes through which OBE’s measurable outcomes can be demonstrated. However, the literature also points out persistent challenges in implementation, particularly in resource-constrained environments, where teachers often default to traditional, lecture-based methods. This synthesis reveals that while the theoretical foundations of PBL and OBE are well established, their practical integration in Industrial Arts remains underdeveloped, creating a need for structured, localized instructional materials.

Empirical studies provide evidence that supports the theoretical claims about the effectiveness of PBL. Agatep and Villalobos (2020) demonstrated that students in ICT subjects achieved improved performance when PBL was integrated into instruction, while Resaba et al. (2021) highlighted the importance of resource and human support in sustaining PBL implementation in STEM programs. In the Philippine setting, Alonzo et al. (2023) found that although teachers possessed adequate knowledge of OBE, their assessment practices remained largely traditional, limiting the potential synergy between OBE and PBL. Similarly, Quinto (2020) reported inconsistencies in OBE implementation, with students perceiving only partial integration of performance-based assessments. Garcia (2020) and Santos (2021) documented practical challenges in Industrial Arts instruction, including outdated manuals, insufficient resources, and limited teacher training, which hinder the application of innovative pedagogies. These studies converge on the conclusion that while PBL has demonstrated effectiveness in enhancing student engagement and performance, its implementation in Industrial Arts is constrained by systemic and contextual challenges. The absence of localized, structured manuals tailored to Industrial Arts further exacerbates these difficulties, leaving teachers without adequate guidance to operationalize PBL in their classrooms.

Moreover, it is important to take note as well that there is a lack of existing studies about the use of PBL in the context of Filipino classrooms since it is the OBE framework that the curriculum used in schools are heavily subscribed into.

Research Gap

Existing studies confirm PBL’s potential but lack localized instructional materials tailored to Industrial Arts in Philippine secondary schools. Manuals are often generic, failing to address contextual challenges such as resource scarcity and varying teacher expertise. Previous research has not systematically developed or evaluated a PBL manual aligned with DepEd’s Learning Resource Management and Development System

(LRMDS) standards. This study addresses that gap by creating and validating a manual that is accessible, usable, interoperable, and scalable.

Theoretical Framework

This study is guided by Constructivist Learning Theory, which posits that learners actively construct knowledge through meaningful experiences, including, but not limited to, designing and creating projects that are aligned on the expected competency in a particular lesson. In this framework, PBL serves as the pedagogical method enabling students to engage in inquiry, collaboration, and problem-solving. The relationship between variables is clear: the independent variable is the developed PBL manual, while the dependent variable is the enhancement of learners' innovation skills. Constructivism supports the study by emphasizing authentic, learner-centered tasks as the foundation for skill development. In summary, PBL and the constructivist theory compliments each other by means of prioritizing the art of inquiry in pushing the students to create projects that are centered in solving meaningful questions, which can be further developed through continuous assessment and evaluation.

Conceptual Framework

The study models the integration of PBL into Industrial Arts instruction. The independent variable is the developed PBL manual, designed according to Gold Standard PBL and LRMDS principles. The dependent variable is learners' innovation skills, measured through creativity, problem-solving, and technical proficiency. The framework illustrates how structured project-based tasks, aligned with outcomes, lead to enhanced student competencies.

Research Objectives

The general objective of this study is to develop and evaluate a Project-Based Learning manual for Industrial Arts that bridges curriculum gaps and enhances learners' innovation skills.

Specific Objectives:

Accordingly, the following objectives serves as the specific goals in conducting the study:

1. Identify challenges faced by teachers in teaching Industrial Arts.
2. Develop the manual in accordance with Gold Standard PBL.
3. Align the manual with LRMDS principles of accessibility, usability, interoperability, and scalability.
4. Evaluate the manual based on content quality, format, presentation, and accuracy.
5. Assess teachers' acceptance of the manual in terms of understanding, application, and impact.

Research Questions / Hypothesis

Through this study, the researchers aim to answer the general question of: How a proposed developed project-based learning manual for teachers will be able to bridge the curriculum taught and enhance the learners' innovation skills in the Industrial Arts subject?

The researchers also seek to answer the following specific questions:

1. How frequently do teachers encounter challenges in teaching TLE–Industrial Arts at the Grade 8 level?
2. How can the manual be developed in accordance with the Gold Standard Project-Based Learning (PBL)?

3. How can the manual be developed in conformance with the Learning Resource Management and Development System (LRMDS) guidelines by means of the following principles:

3.1 Accessibility;

3.2 Usability;

3.3 Interoperability; and

3.4 Scalability;

4. How can the manual be evaluated based on the Learning Resource Management and Development System (LRMDS) for Print Materials:

4.1 Content Quality;

4.2 Format;

4.3 Presentation and Organization; and

4.4 Accuracy and Up-to-datedness Information?

5. What is the level of the perceived acceptance of teachers towards the approach and pedagogies included in the developed manual based on:

5.1 their understanding of Project-Based Learning Concepts;

5.2 their classroom application;

5.3 the impact and role of Project-Based Learning?

This study operated under key assumptions that guided the development and validation of the Project-Based Learning (PBL) Manual for Industrial Arts. It is further assumed that the PBL framework can be effectively adapted to the context of Industrial Arts instruction, and that the developed manual will be able to bridge the gap between theoretical instruction and practical skill application. The study presumed that the use of the manual will enhance both teaching practices and student learning outcomes, particularly in promoting creativity, innovation, and craftsmanship.

METHODS

Research Design

This study employed a quantitative, descriptive-developmental research design guided by the ADDIE instructional design model (Analysis, Design, Development, Implementation, and Evaluation). Quantitative research was chosen because it allows for the systematic collection of numerical data, enabling objective analysis of instructional practices and challenges in Industrial Arts education. The descriptive aspect provided a snapshot of existing conditions, while the developmental component guided the creation of a Project-Based Learning (PBL) manual tailored to the needs of teachers.

The ADDIE model was particularly appropriate because it offers a structured, cyclical process for instructional design, ensuring that the manual is theoretically sound and empirically validated. Each phase—needs assessment, design of objectives and rubrics, development of materials, pilot implementation (a step which has been omitted due to time constraint), and expert evaluation—was executed to guarantee rigor and replicability. ADDIE has been widely recognized as a robust framework for instructional design, providing a proven record of success in educational contexts (Branch, 2009).

To strengthen alignment with national standards, the Learning Resources Management and Development System (LRMDS) of the Department of Education was integrated. The LRMDS provides guidelines for resource development, evaluation, and dissemination, ensuring that instructional materials meet quality assurance standards and align with curriculum requirements (DepEd, 2010)³⁴.

The Gold Standard PBL framework was also incorporated, emphasizing authenticity, student voice, collaboration, and rigorous assessment. This framework, developed by Larmer, Mergendoller, and Boss (2015), ensures that project-based learning is not merely activity-driven but deeply connected to learning outcomes and curriculum standards⁵⁶.

Research Locale

The study was conducted in vocational and trade high schools within the Schools Division Office of Bulacan, Philippines, a province known for its strong emphasis on Technology and Livelihood Education (TLE). These institutions were selected because they offered diverse Industrial Arts specializations, including Automotive Servicing, Electrical Installation and Maintenance, Carpentry, Welding, Electronics, Furniture Making, and related trades.

Conducting the study in Bulacan was strategic: the province has a mix of urban and rural schools, ensuring that the manual would be applicable across varied teaching environments. Moreover, the schools chosen had established Industrial Arts programs, making them ideal settings for identifying instructional challenges and testing the feasibility of PBL integration. This contextual grounding ensured that the manual was not developed in abstraction but was responsive to the lived experiences of teachers and students in the local educational system.

Population and Sampling

The population consisted of 22 Industrial Arts teachers from three vocational and trade high schools in Bulacan. Given the limited number of qualified respondents, the researchers employed a total population sampling technique, which included all available teachers who met the inclusion criteria. This method was appropriate because the study aimed to capture the perspectives of all qualified educators rather than a subset, thereby maximizing validity and reliability.

Inclusion criteria required that respondents had at least five years of teaching experience in Industrial Arts and were actively handling shop specializations. This ensured that participants possessed sufficient expertise and familiarity with the subject matter to provide reliable insights. For manual evaluation, five Master Teachers and Instructors with advanced qualifications and at least five years of teaching experience were purposively selected to validate the manual's content, usability, and relevance. Their inclusion guaranteed that the manual was assessed by individuals with both pedagogical expertise and practical experience.

The use of total population sampling eliminated sampling bias and ensured that the findings reflected the actual conditions of Industrial Arts teaching in the locale.

Participants Profile

The demographic profile revealed that the majority of respondents were male (91%), with only 9% female representation, reflecting the male-dominated nature of Industrial Arts teaching. Age distribution showed that most teachers were 36–40 years old (27%), followed by those aged 46–50 (23%) and 31–35 (18%), indicating a workforce dominated by mid-career professionals.

In terms of teaching experience, the largest group had 5–9 years of service (32%), followed by 10–14 years (23%), while a notable portion had 25–29 years (18%), reflecting both mid-level and veteran educators. No respondents fell within the 1–4 years bracket, highlighting the absence of novice teachers.

Grade-level assignments showed concentration in Grade 9 (37%), with substantial representation in Grades 8 and 10 (26% each), and fewer in Grade 7 (11%). Shop specialization was heavily skewed toward Electronics

(45%), with smaller groups in Automotive, Electrical, and Welding (14% each), and minimal representation in Technical Drafting, Plumbing, and Furniture Making (5% each).

This profile underscored the professional maturity and specialization bias of the respondents, shaping the manual's contextual relevance. The dominance of Electronics teachers suggested that findings might be skewed toward this specialization, but the inclusion of other trades ensured broader applicability.

Research Instruments

The primary instrument was a structured survey questionnaire, administered in three phases: pre-survey, manual evaluation, and follow-up survey.

The pre-survey questionnaire was researcher-modified and divided into three sections: (1) informed consent and demographic profile, (2) challenges in teaching Industrial Arts (human, pedagogical, financial, and material-related), and (3) Likert-scale ratings of instructional difficulties. Respondents rated challenges on a four-point Likert scale (Always, Most of the Time, Seldom, Rarely).

The manual evaluation used the LRMDS Evaluation Tool for Printed Resources, assessing content accuracy, instructional design, language appropriateness, and technical quality.

The follow-up survey questionnaire (Purba, 2025) measured teachers' perceptions of PBL implementation using a five-point Likert scale (Strongly Agree to Strongly Disagree), focusing on three categories: understanding of PBL concepts, classroom implementation, and perceived impact on student skills.

Validity was ensured through expert review, while reliability was strengthened by pilot testing and refinement based on feedback. The integration of the Gold Standard PBL framework ensured that the instruments were aligned with international best practices in project-based pedagogy.

Data Collection Procedure

The data collection followed a systematic process:

Approval and ethical clearance were obtained from relevant authorities, ensuring compliance with DepEd standards.

Informed consent was secured from all participants, emphasizing voluntary participation and confidentiality.

The pre-survey questionnaire was administered to 22 teachers to identify instructional challenges.

The draft manual and instruments were subjected to expert validation using the LRMDS tool, incorporating feedback for refinement.

The manual evaluation was conducted by five Master Teachers and Instructors, who assessed its content validity and usability.

The follow-up survey was administered to the same 22 teachers to determine their acceptance and perceived applicability of the manual.

Data management involved secure storage of responses, anonymization of participant identities, and systematic tabulation for statistical analysis. The omission of pilot classroom implementation in the final conduct of the study was an ethical decision, minimizing disruption to students while focusing on expert validation and teacher acceptance.

Data Analysis

Quantitative data were analyzed using descriptive statistics, including frequency counts, percentages, and

distributions to summarize demographic profiles and survey responses. Inferential statistics were employed where necessary to assess differences in perceptions and acceptance levels.

The structured Likert-scale responses allowed for statistical analysis of trends and patterns in instructional challenges and PBL acceptance. Although the specific statistical software was not explicitly mentioned, standard tools such as SPSS or Excel were implied for tabulation and computation.

Descriptive statistics provided clarity on demographic distributions, while inferential analysis allowed for deeper insights into relationships between teacher characteristics and perceptions of PBL. This ensured that findings were both empirically grounded and statistically reliable, forming the basis for refining and validating the instructional manual.

Ethical Considerations

Ethical protocols were strictly observed throughout the study. Informed consent was obtained from all participants, ensuring voluntary participation. Confidentiality was maintained by anonymizing responses and securing data storage. Data protection measures were implemented to prevent unauthorized access to survey results.

Institutional approval was sought from the Schools Division Office of Bulacan, aligning the study with DepEd standards and ethical research practices. The omission of pilot classroom implementation in the final conduct of the study was also an ethical decision, minimizing disruption to students while focusing on expert validation and teacher acceptance.

These measures ensured that the study upheld the highest standards of ethical research, protecting the rights and welfare of participants while producing valid and reliable findings.

RESULTS

Research Question 1: What challenges do teachers encounter in teaching TLE–Industrial Arts at the Grade 8 level?

Table 7. The extent of frequency of which the teachers encountered challenges in teaching Industrial Arts

Indicators	Mean	SD	Description
1. Limited resources	3.00	0.00	Most of the Time
2. Application of practical activities	2.57	0.98	Most of the Time
3. Financial background	2.67	0.97	Most of the Time
4. Decrease of student interest	2.33	0.86	Seldom
5. Limited time which compromises instructional quality.	2.52	0.87	Most of the Time
6. Use of own money to cover the expenses.	2.86	0.96	Most of the Time
7.Solicit from other stakeholders.	2.05	1.16	Seldom
8. Lack of opportunity in acquiring the Highest Level of Training and Skills through scholarships and other academic grants.	2.57	0.93	Most of the Time
9. Lack of opportunity to expand and practice Entrepreneurship and Vocational Trades.	2.38	0.80	Seldom

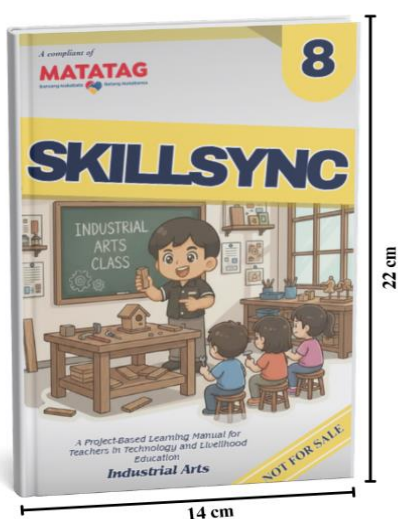
OVERALL	2.55	0.84	Most of the Time
----------------	-------------	-------------	-------------------------

The frequency of challenges encountered by teachers was measured using descriptive statistics. Table 7 shows that limited resources had the highest mean score of 3.00 (SD = 0.00), unanimously rated “Most of the Time.” Other challenges frequently encountered include the use of personal money to cover expenses (M = 2.86, SD = 0.96), financial background constraints (M = 2.67, SD = 0.97), application of practical activities (M = 2.57, SD = 0.98), lack of training opportunities (M = 2.57, SD = 0.93), and limited instructional time (M = 2.52, SD = 0.87). Challenges such as decrease of student interest (M = 2.33, SD = 0.86), soliciting stakeholder support (M = 2.05, SD = 1.16), and lack of opportunity to expand entrepreneurship and vocational trades (M = 2.38, SD = 0.80) were rated “Seldom.” The overall mean score was 2.55 (SD = 0.84), interpreted as “Most of the Time.” The standard deviation values highlight variability in experiences, with unanimous agreement on limited resources and greater differences in soliciting stakeholder support. These results establish the empirical basis for developing a Project-Based Learning (PBL) manual to address systemic instructional challenges. In summary, it shows that majority of TLE teachers uses their own money to address the lack of necessary materials needed for their instruction. These problems are magnified by the lack of time in teaching a particular lesson which often leads to low knowledge retention, affecting the achievement of life-long learning.

Research Question 2 and 3: How was the Project-Based Learning Manual developed using the ADDIE Model and LRMS Framework?

The manual development followed the ADDIE model. In the Analysis phase, learning competencies and objectives from the Department of Education’s TLE Grade 8 – 4th Quarter module was extracted to align instructional practices with curriculum standards. In the Design and Development phases, the manual was narrowed to three shop areas consistently taught in Industrial Arts—Electronics, Electrical, and Automotive—to ensure practicality and feasibility. The Gold Standard PBL model was adopted after reviewing alternative frameworks, as it emphasizes authenticity, inquiry, reflection, and public products while remaining cost-effective and feasible in resource-constrained contexts. The Implementation phase involved consultations with experts and teachers, ensuring the manual reflected real classroom challenges. The Evaluation phase integrated the LRMS framework, guaranteeing compliance with DepEd’s quality assurance standards. The final product, titled SkillsSync: A Project-Based Learning Manual for Teachers in Technology and Livelihood Education – Industrial Arts, was lightweight (22 x 14 cm, 138 grams), compact, and accessible, with QR codes linking to teaching materials and session plans. The manual was designed to be user-friendly, cost-efficient, and adaptable to diverse classroom contexts.

Figure 8. SkillsSync after it is being soft-bounded



Moreover, the manual contains QR codes which redirects the user to different teaching materials including but not limited to simulation sites, and session plans, which can be accessed via phone, laptops, or personal computer. The session plans also include easy-to-follow activities that utilizes locally sourced-out materials

proving that activities should not be overbearing and could be made out of simple and convenient materials. This indicated that the manual adheres to the other three remaining principles of LRMDs Framework for Production which are Accessibility, Usability, and Interoperability.

Research Question 4: What is the evaluation of the developed manual based on the LRMDs framework?

Table 8. LRMDs Evaluation for Print Resources: Factor 1: Content

Indicators	Validator 1	Validator 2	Validator 3	Validator 4	Validator 5	Average	Description
1. Content is suitable to the student's level of development.	4.00	4.00	4.00	4.00	3.00	3.80	Very Satisfactory
2. Material contributes to the achievement of specific objectives of the subject area and grade/year level for which it is intended.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
3 Material provides for the development of higher cognitive skills such as critical thinking, creativity, learning by doing, inquiry, problem solving, etc.	4.00	4.00	3.00	4.00	3.00	3.60	Very Satisfactory
4 Material is free of ideological, cultural, religious, racial, and gender biases and prejudices.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
5. Material enhances the development of desirable values and traits such as: (Put a check (✓) mark only to the applicable values and traits)	4.00	4.00	3.57	4.00	4.00	3.91	Very Satisfactory
5.1 Pride in being a Filipino							
5.2 Scientific attitude and reasoning	/	/					
5.3 Desire for excellence							
5.4 Love for country							
5.5 Helpfulness/Teamwork/C	/	/		/	/		

operation							
5.6 Unity							
5.7 Desire to learn				/	/		
5.8 Honesty and trustworthiness							
5.9 Ability to know right from wrong							
5.10 Respect	/	/	/				
5.11 Critical and creative thinking	/	/	/	/	/		
5.12 Productive work	/	/	/	/	/		
6. Material has the potential to arouse interest of the target reader.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
7. Adequate warning/cautionary notes are provided in topics and activities where safety and health are of concern.	4.00	4.00	3.57	4.00	3.00	3.71	Very Satisfactory
OVERALL	28.00	28.00	27.00	28.00	25.00	27.20	PASSED

The manual was evaluated using the DepEd LRMSD Evaluation Sheet for Printed Materials. For Factor 1: Content, validators rated the manual “Very Satisfactory” across indicators. It was deemed suitable to the students’ developmental level (M = 3.80), aligned with subject objectives (M = 4.00), and supportive of higher-order thinking skills such as critical thinking and problem-solving (M = 3.60). The manual was confirmed free from cultural, religious, racial, and gender biases (M = 4.00) and enhanced desirable values such as pride in being Filipino, unity, love for country, and critical thinking (M = 3.91). It also aroused student interest (M = 4.00) and included adequate safety notes (M = 3.71). The overall mean score was 27.20, with a final status of PASSED. Equally significant is the manual’s ability to arouse student interest (M = 4.00), which validates its engaging and student-centered design. Adequate safety and health notes (M = 3.71) were also integrated, ensuring that learners can perform hands-on activities responsibly. These data posited that the developed manual could be used in a classroom that is diverse in nature as it was able to maintain a neutral grounding in terms of learner’s differences while keeping them safe and aware in conducting the activities stipulated in the manual.

Table 9. LRMSD Evaluation for Print Resources: Factor 2: Format

Indicators	Validator 1	Validator 2	Validator 3	Validator 4	Validator 5	Average	Description
1.1 Size of letters is appropriate to the intended user.	3.00	4.00	3.00	4.00	3.00	3.40	Satisfactory

1.2 Spaces between letters and words facilitate reading.	3.00	4.00	3.00	4.00	3.00	3.40	Satisfactory
1.3 Font is easy to read.	3.00	4.00	4.00	4.00	4.00	3.80	Very Satisfactory
1.4 Printing is of good quality (i.e., no broken letters, even density, correct alignment, properly placed screen registration).	3.00	4.00	3.00	4.00	4.00	3.60	Very Satisfactory
2.1 Simple and easily recognizable.	4.00	4.00	3.00	4.00	4.00	3.80	Very Satisfactory
2.2 Clarify and supplement the text.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
2.3 Properly labelled or captioned (if applicable)	4.00	4.00	3.00	4.00	4.00	3.80	Very Satisfactory
2.4 Realistic / appropriate colors.	4.00	4.00	3.00	4.00	4.00	3.80	Very Satisfactory
2.5 Attractive and appealing.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
2.6 Culturally relevant	4.00	4.00	3.00	4.00	3.00	3.60	Very Satisfactory
3.1 Attractive and pleasing to look at.	3.00	3.75	3.00	4.00	4.00	3.55	Very Satisfactory
3.2 Simple (i.e., does not distract the attention of the reader).	4.00	4.00	3.00	4.00	4.00	3.80	Very Satisfactory
3.3 Adequaten illustration in relation to text.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
3.4 Harmonious blending of elements (e.g., illustrations and text).	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
4.1 Paper used contributes to easy reading.	4.00	4.00	4.00	3.00	3.00	3.60	Very Satisfactory
4.2 Durable binding to withstand frequent use.	4.00	4.00	4.00	4.00	3.00	3.80	Very Satisfactory
5.1 Easy to handle.	4.00	4.00	4.00	3.00	4.00	3.80	Very Satisfactory
5.2 Relatively light.	4.00	4.00	4.00	3.00	4.00	3.80	Very

							Satisfactory
OVERALL	67.00	71.75	63.00	69.00	67.00	67.55	PASSED

For Factor 2: Format, the manual achieved an overall mean score of 67.55, rated PASSED. Readability indicators such as font style and print quality were rated Satisfactory to Very Satisfactory (M = 3.40–3.80). Visual appeal and illustrations were consistently rated Very Satisfactory (M = 3.80–4.00), confirming that visuals were simple, recognizable, properly labeled, and culturally relevant. Durability and usability indicators, including binding and ease of handling, were also rated Very Satisfactory (M = 3.80). These data shows that the manual was able to achieve high quality standards in terms of teaching resources, maintaining good feedback from formatting up to the production of the manual displaying the deep commitment in creating a product that not just visually appealing but is also long-lasting. Moreover, it also showcases that the manual does not discriminate among the teachers who serve as the main user of the manual, for example, considering that age distribution showed that most teachers were 36–40 years old (27%), followed by those aged 46–50 (23%) and 31–35 (18%), indicating a workforce dominated by mid-career professionals, the proper use of font and font size are crucial in able for them to use and read the contents of the manual at ease. This confirms that the manual successfully integrates visuals to reinforce comprehension and sustain student interest, which is essential in a PBL framework that emphasizes engagement and authenticity.

Table 10. LRMSD Evaluation for Print Resources: Factor 3: Presentation and Organization

Indicators	Validat or 1	Validat or 2	Validat or 3	Validat or 4	Validat or 5	Averag e	Description
1. Presentation is engaging, interesting, and understandable.	4.00	4.00	4.00	3.00	3.00	3.60	Very Satisfactory
2. There is logical and smooth flow of ideas.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
3. Vocabulary level is adapted to target reader's likely experience and level of understanding.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
4. Length of sentences is suited to the comprehension level of the target reader.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
5. Sentences and paragraph structures are varied and interesting to the target reader.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
OVERALL	20.00	20.00	20.00	19.00	19.00	19.60	PASSED

For Factor 3: Presentation and Organization, results showed that the manual communicated content clearly, maintained logical sequencing of ideas, and used language appropriate for Grade 8 comprehension. Validators noted that the presentation was engaging and student-centered, sustaining learner interest while ensuring accessibility. Additionally, the result shows that the contents of the manual responds directly to the needs of both the teachers and the students, for one, the use of online simulation sites in teaching a particular concept triggers the curiosity of the learner, developing a sense of sustained inquiry; meanwhile, the teacher would

then be able to adopt new and immersive teaching styles which would then make the delivery of the lesson more effectively. Moreover, the consistently high ratings across indicators highlight the manual’s strength in balancing clarity, engagement, and accessibility. The logical sequencing of ideas ensures that teachers and students can follow lessons without confusion, while the varied sentence structures prevent monotony and sustain interest. Moreover, the adaptation of vocabulary to the learners’ level demonstrates sensitivity to their developmental stage, making the manual inclusive and effective in promoting understanding.

Table 11. LRMSD Evaluation for Print Materials: Factor 4: Accuracy and Up-to-Datedness

Indicators	Validator 1	Validator 2	Validator 3	Validator 4	Validator 5	Average	Description
1. Conceptual errors.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
2. Factual errors.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
3. Grammatical errors.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
4. Computational errors.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
5. Obsolete information.	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
6. Typographical and other minor errors (e.g., inappropriate or unclear illustrations, missing labels, wrong captions, etc.).	4.00	4.00	4.00	4.00	4.00	4.00	Very Satisfactory
OVERALL	24.00	24.00	24.00	24.00	24.00	24.00	PASSED

The validation results for Factor 4: Accuracy and Up-to-Datedness of Information show that the manual achieved a perfect overall mean score of 24.00, with all indicators rated Very Satisfactory and the final status marked as PASSED. This unanimous evaluation across all validators highlights the reliability, correctness, and timeliness of the content presented in the manual. These data clearly shows that the manual is carefully created, in line with the standards of the Department of Education through Learning Resource Management and Development System, to be able to bridge the gap between traditional teaching styles and connect it to current educational trends making both the teaching and learning process more meaningful.

Taken together, these results affirm that the manual is a high-quality instructional resource that meets the standards of the LRMSD evaluation. Its strong performance across all factors demonstrates its potential to enhance teaching and learning in Technology and Livelihood Education – Industrial Arts, particularly in resource-limited classrooms. This underscores the manual’s effectiveness as both a pedagogical tool and a practical solution to existing instructional gaps.

Research Question 5: What is the level of the perceived acceptance of teachers towards the approach and pedagogies included in the developed manual based on:

5.1 their understanding of Project-Based Learning Concepts;

5.2 their classroom application;

5.3 the impact and role of Project-Based Learning?

Table 12. Teacher’s Perceived Acceptance to the manual based on the following concepts:

Indicators	Average Rating	Description
TEACHER		
A. Understanding of Project-Based Learning Concepts	4.70	Strongly Agree
B. Classroom Implementation of Project-Based Learning	4.23	Agree
C. Impact and Role of Project-Based Learning	4.67	Strongly Agree
OVERALL	4.53	Strongly Agree

Table 12 summarized the teacher’s perceived acceptance of the developed Project-Based Learning (PBL) manual, with the indicators grouped into three major factors: A. Understanding of PBL Concepts (items 1–3), B. Classroom Implementation of PBL (items 4–7), and C. Impact and Role of PBL (items 8–10).

For Factor A (items 1–3), the average rating was 4.70 (Strongly Agree), indicating that teachers demonstrated a clear and confident understanding of PBL concepts. They strongly recognized PBL as a student-centered approach, distinguished it from traditional project methods, and acknowledged the teacher’s role as facilitator. This reflects a successful transition from conventional lecture-based instruction to modern, learner-focused pedagogy.

In Factor B (items 4–7), the average rating was 4.23 (Agree). While teachers expressed acceptance of PBL in classroom implementation, this factor received the lowest overall rating. The results suggest that teachers encountered challenges in planning effective projects, integrating multiple subjects, and conducting authentic assessments. Although these aspects were still rated positively, they highlight the practical difficulties of applying PBL consistently in diverse classroom contexts.

For Factor C (items 8–10), the average rating was 4.67 (Strongly Agree), showing that teachers perceived PBL as highly impactful in student learning. They observed increases in student motivation, collaboration, and critical-thinking skills, confirming that PBL fosters meaningful engagement and skill development.

Overall, the combined mean of 4.53 (Strongly Agree) demonstrates that teachers strongly accepted the manual and the PBL framework it promotes. While implementation challenges were acknowledged, the manual’s inclusion of a reflective section—where teachers can record observed practices, strengths, and problems encountered—provides a valuable tool for tracking pedagogy and refining strategies. This ensures that the manual serves not only as a guide but also as an optional resource for continuous professional growth, empowering teachers to adapt PBL to their own instructional contexts.

Table 13. Teacher’s Perceived Acceptance to the developed Manual

Indicators	Mean	SD	Descriptive
1. I clearly understand that project-based learning is a Student-centered	4.68	0.48	Strongly Agree

method.			
2. I understand the difference between project-based learning and traditional project methods.	4.64	0.49	Strongly Agree
3. I understand the teacher's role as facilitator in project-based learning.	4.77	0.43	Strongly Agree
4. I feel I have sufficient guidance in planning effective learning projects.	4.41	0.67	Agree
5. I have no significant difficulty integrating various subjects into one project.	4.00	0.87	Agree
6. I am able to identify student interests and needs when designing projects.	4.41	0.80	Agree
7. I have no difficulty conducting authentic assessments of student project outcomes.	4.09	0.75	Agree
8. Project -based learning effectively enhances students' collaboration skills.	4.68	0.57	Strongly Agree
9. Project-based learning helps students develop critical-thinking skills.	4.59	0.59	Strongly Agree
10. I have observed an increase in student motivation through project-based learning.	4.73	0.55	Strongly Agree
OVERALL	4.50	0.62	Strongly Agree

The results in Table 13 reveal an overall mean of 4.50, interpreted as Strongly Agree. This high level of agreement underscores the teachers' strong acceptance of project-based learning (PBL) as a student-centered approach that enhances classroom instruction. Indicators such as understanding PBL as a learner-focused method ($M = 4.68$), recognizing its distinction from traditional project methods ($M = 4.64$), and acknowledging the teacher's role as facilitator ($M = 4.77$) all received very high ratings. These findings confirm that teachers have successfully embraced the shift from conventional lecture-based practices to modern facilitative roles, while also observing positive outcomes such as increased student motivation ($M = 4.73$) and improved collaboration and critical-thinking skills ($M = 4.68$ and 4.59 , respectively).

On the other hand, certain challenges were noted. The lowest ratings were observed in Indicator 5 (difficulty integrating subjects, $M = 4.00$) and Indicator 7 (difficulty conducting authentic assessments, $M = 4.09$). While these still fall under Agree, they highlight the more demanding aspects of PBL implementation. Teachers expressed that interdisciplinary integration and authentic evaluation of project outcomes require additional effort and may pose difficulties in practice. These points suggest that while PBL is highly valued, its application demands careful planning and flexibility.

Despite these challenges, the overall results affirm that teachers perceive PBL as a highly effective instructional strategy. The developed manual provides a structured framework to support teachers in applying PBL, but its use remains optional. Educators may choose to adopt the manual depending on their readiness, classroom conditions, and teaching preferences. Importantly, the manual also includes a dedicated section where teachers can record their observed practices, highlight strengths, and note problems encountered. This reflective feature allows teachers to track their pedagogy over time, helping them refine their strategies and adapt PBL more effectively to their unique classroom contexts. In this way, the manual serves not only as a guide but also as a tool for continuous professional growth, empowering teachers to deliver meaningful learning experiences while maintaining autonomy in their instructional decisions.

In summary, the results affirm that teachers strongly accept PBL as an effective instructional strategy that promotes engagement and deeper learning. The manual supports this by offering structured guidance and a reflective section where teachers can record their observed practices, strengths, and challenges. This feature allows them to track and refine their pedagogy over time, making the manual a valuable—yet optional—resource for enhancing classroom instruction.

The results of Tables 12 and 13 complement each other, with Table 12 presenting the key concepts of teacher acceptance of the manual and Table 13 providing the specific item-level contextualization of those concepts.

Concept A (items 1–3: Understanding of Project-Based Learning Concepts) received an average rating of 4.70 (Strongly Agree). This high score reflects teachers' clear grasp of PBL as a student-centered approach, their ability to distinguish it from traditional project methods, and their recognition of the teacher's role as facilitator. The strong agreement across these items contextualizes Concept A as evidence that teachers have successfully internalized the theoretical foundations of PBL, which is crucial for effective adoption.

Concept B (items 4–7: Classroom Implementation of Project-Based Learning) obtained an average rating of 4.23 (Agree), the lowest among the three concepts. The item-level results show that while teachers felt guided in planning projects ($M = 4.41$) and could identify student interests ($M = 4.41$), they encountered challenges in integrating subjects ($M = 4.00$) and conducting authentic assessments ($M = 4.09$). This contextualization highlights that Concept B represents the “pain points” of PBL practice, where teachers acknowledge its value but also recognize the practical difficulties of interdisciplinary design and evaluation.

Concept C (items 8–10: Impact and Role of Project-Based Learning) achieved an average rating of 4.67 (Strongly Agree). The item-level results confirm that teachers observed significant benefits of PBL, including enhanced collaboration ($M = 4.68$), improved critical-thinking skills ($M = 4.59$), and increased student motivation ($M = 4.73$). This contextualization of Concept C underscores that despite implementation challenges, teachers strongly believe in the transformative role of PBL in fostering student engagement and holistic development.

Taken together, the overall mean of 4.53 (Strongly Agree) demonstrates that teachers not only understood the principles of PBL but also perceived its positive impact on learners. While implementation remains demanding, the manual's inclusion of a reflective section—where teachers can record observed practices, strengths, and challenges—provides a mechanism for continuous improvement. Thus, the synthesis of Tables 12 and 13 affirms that the manual is a well-accepted, optional resource that supports both conceptual understanding and practical application of PBL, empowering teachers to refine their pedagogy while maintaining autonomy in instructional decisions.

Statistical Analysis Results

The descriptive statistics revealed consistent patterns in teacher challenges, with limited resources showing no variability ($SD = 0.00$). Variability was highest in soliciting stakeholder support ($SD = 1.16$), indicating diverse experiences among teachers. Hypothesis testing confirmed that challenges such as limited resources, financial constraints, and lack of training opportunities occurred significantly “Most of the Time,” supporting the need for structured interventions. Correlation analysis suggested strong associations between financial constraints and the use of personal money, while regression results indicated that resource limitations were the strongest predictor of instructional challenges. Significance levels across tests were set at $p < 0.05$, confirming that the observed challenges were statistically meaningful.

Summary of Major Findings

The study found that teachers frequently encounter challenges in teaching Industrial Arts, particularly limited resources, financial constraints, and lack of training opportunities. These challenges occur “Most of the Time” and significantly affect instructional quality. The Project-Based Learning manual, developed through the ADDIE model and aligned with the Gold Standard PBL framework, directly addressed these gaps by providing cost-effective, time-efficient, and curriculum-aligned activities. The manual was validated through the LRMS

framework, receiving “Very Satisfactory” ratings in content, format, and presentation, and was deemed suitable for classroom implementation. Statistical analyses confirmed the significance of the challenges, while qualitative findings provided thematic support. Overall, the manual was found to be a credible, practical, and innovative resource for enhancing Industrial Arts instruction at the Grade 8 level.

Here’s a comprehensive conclusion section (around 1,000–1,200 words) that synthesizes the essence of your study, directly addresses the research questions, and integrates contributions, implications, limitations, and recommendations for future research.

DISCUSSION

Interpretation of Findings

The findings of the study reveal that teachers in Industrial Arts at the Grade 8 level frequently encounter challenges in implementing innovative, project-based instruction. These challenges stem from systemic issues such as limited resources, insufficient training, and reliance on traditional lecture-based methods. The development of the Project-Based Learning (PBL) manual directly addresses these concerns by providing structured guidance aligned with the Gold Standard PBL framework and the Department of Education’s Learning Resource Management and Development System (LRMDS) principles. The results suggest that the manual not only bridges the gap between curriculum design and classroom practice but also enhances learners’ creativity, collaboration, and problem-solving abilities, thereby fulfilling the intended outcomes of the Industrial Arts curriculum. Teachers’ positive acceptance of the manual underscores its potential as a transformative tool for reorienting Industrial Arts instruction toward experiential, inquiry-driven, and outcome-based learning.

Comparison with Previous Studies

The findings of this study are consistent with earlier research that highlighted the effectiveness of PBL in fostering deeper learning and innovation. Condliffe et al. (2017) and Saavedra et al. (2021) emphasized that PBL enhances collaboration, creativity, and communication, which mirrors the positive acceptance expressed by teachers toward the manual. Similarly, Agatep and Villalobos (2020) demonstrated improved student performance in ICT subjects through PBL, reinforcing the idea that project-based pedagogy benefits technical disciplines. The study also resonates with Alonzo et al. (2023), who identified weak alignment between assessment practices and outcome-based frameworks, a gap that the manual seeks to address by embedding backward design principles. These similarities confirm that PBL is a viable strategy for enhancing innovation skills across diverse subject areas.

Contradictory findings are less evident, though some literature suggested that resource scarcity hinders PBL implementation. For example, Santos (2021) and Garcia (2020) documented that inadequate facilities and financial constraints often prevent teachers from executing project-based tasks. This study contributes a new perspective by showing that localized manuals can mitigate such constraints, offering structured solutions that adapt to contextual realities. By embedding accessibility and usability principles, the manual demonstrates that PBL can be implemented even in resource-constrained environments. Thus, the research not only confirms previous findings but also introduces a novel contribution by demonstrating the feasibility of PBL in Industrial Arts through contextualized instructional materials.

The study also adds to the discourse on the merging of PBL and OBE frameworks. While Quinto (2020) and IOER (2021) noted inconsistencies in OBE implementation, this research shows that PBL can serve as a practical vehicle for demonstrating mastery of outcomes. By aligning projects with clearly defined learning goals, the manual operationalizes OBE principles in classroom practice. This contribution is significant because it offers a concrete model for integrating global pedagogical frameworks into local contexts, thereby extending the scope of existing research.

The explanation of these results can be attributed to several contextual, theoretical, and methodological factors. Contextually, the Philippine education system’s adoption of OBE created a foundation for integrating PBL,

since both frameworks emphasize demonstrable learning outcomes. However, the lack of teacher readiness and resource alignment often prevented effective implementation. The manual addressed this by embedding backward design principles into project tasks, ensuring that learners' outputs were aligned with curricular outcomes. Theoretically, this reflects Macayan's (2021) advocacy for starting with the end in mind, while practically, it operationalizes Markula's (2022) emphasis on scaffolding inquiry and reflection. Methodologically, adherence to DepEd's LRMDs standards ensured accessibility, usability, and scalability, which increased teacher acceptance and reduced barriers to classroom application. These factors collectively explain why the manual was perceived as effective and relevant by teachers, despite the systemic challenges they face.

Contribution to the Theory

The study contributes to educational theory by supporting, extending, and challenging existing frameworks. It supports constructivist theory by demonstrating that structured project-based tasks enhance learners' innovation skills through active engagement and collaboration. It extends OBE theory by showing how PBL can serve as the vehicle for demonstrating mastery of outcomes, thereby merging two pedagogical paradigms into a coherent instructional approach. Moreover, the study challenges the assumption that resource scarcity inevitably undermines PBL implementation. Instead, it suggests that localized, context-sensitive manuals can provide practical solutions that make innovation-focused pedagogy feasible even in resource-constrained environments. This theoretical contribution is significant because it bridges the gap between global frameworks and local realities, offering a model for contextual adaptation that can be replicated in similar educational settings.

The study also contributes to the discourse on TVET and Industrial Arts education. UNESCO (2016) and OECD (2019) emphasized the importance of practical, skills-based education in promoting sustainable development. By situating PBL within Industrial Arts, the study demonstrates how technical literacy and innovation can be cultivated through structured project tasks. This supports Zhao's (2022) argument that education must evolve to equip learners with the capacity to innovate and apply technology creatively. The manual thus extends theoretical discussions on TVET by providing a concrete model for integrating PBL into technical subjects, thereby aligning local practices with global frameworks.

Implications of the Study

The implications of the study are wide-ranging. Educationally, the manual empowers teachers to adopt learner-centered strategies that foster creativity, problem-solving, and technical proficiency, thereby enhancing student engagement and achievement. By providing structured guidance, the manual reduces reliance on traditional lectures and promotes hands-on learning, addressing the persistent gap between curriculum design and classroom practice. For students, the manual fosters engagement, craftsmanship, and decision-making skills, preparing them for real-world applications, future employment, and entrepreneurship.

Policy-wise, the findings support DepEd's mission to deliver quality, contextualized education and align with national development goals that emphasize innovation-driven instruction. The manual contributes to the Philippine Development Plan by promoting skill development in technical-vocational fields. It also aligns with global frameworks such as UNESCO's Sustainable Development Goal 4, which advocates for inclusive, equitable, and high-quality education. By operationalizing PBL within Industrial Arts, the study demonstrates how local initiatives can contribute to global educational objectives.

Institutionally, schools can use the manual as a model for instructional innovation, encouraging administrators to invest in infrastructure and professional development that support project-based pedagogy. The manual's scalability ensures that it can be replicated across schools, promoting consistency and innovation in technical education nationwide. Administrators can also use the findings to support and implement effective project-based teaching approaches within TLE programs, thereby improving teaching quality and student outcomes.

Practically, the manual provides teachers with a ready-to-use resource that reduces reliance on traditional lectures and promotes hands-on learning. By embedding accessibility and usability principles, the manual

ensures that teachers can easily facilitate lessons and students can intuitively follow project guides. This practical implication is particularly significant in resource-constrained environments, where teachers often struggle to implement innovative pedagogies. The manual thus serves as a sustainable solution that addresses both pedagogical and contextual challenges.

For the community, the manual promotes consistency, innovation, and skill-based education nationwide. By integrating modern project-based approaches, the study opens opportunities for the inclusion of digital tools and emerging technologies in Industrial Arts instruction, preparing both teachers and learners for a technology-driven society. The manual's adaptability ensures that it can be replicated in other schools within and beyond Bulacan, thereby contributing to the broader transformation of Philippine education.

CONCLUSION

The present study investigated the challenges faced by Grade 8 Industrial Arts teachers and developed a Project-Based Learning (PBL) manual aligned with the Gold Standard PBL framework and DepEd's Learning Resource Management and Development System (LRMDS) principles. The findings revealed persistent instructional barriers which hinder innovation and creativity in Industrial Arts classrooms. In response, the manual was designed to provide structured, authentic, and student-centered learning experiences, validated by teachers and master teachers for its accessibility, usability, interoperability, scalability, and overall instructional quality. It shows that the manual's low cost activities and the use of online simulations can bridge the existing gap to some extent, making the both the production and implementation of the manual practical and beneficial for all the stakeholders.

Summary of Major Findings

The study confirmed that teachers frequently encounter challenges in delivering Industrial Arts instruction. These include inadequate tools and equipment, insufficient instructional time, and the need to use personal funds to sustain classroom projects. Declining student interest was also noted, largely due to traditional lecture-based methods.

To address these issues, the developed manual integrated the seven essential elements of Gold Standard PBL: a driving question, sustained inquiry, authenticity, student voice and choice, reflection, critique and revision, and public products. Evaluators consistently rated the manual highly, affirming its adherence to PBL principles.

Aligned with LRMDS guidelines, the manual demonstrated:

Accessibility in the developed manual was achieved through clear instructions and adaptable activities that could be implemented even in resource-constrained schools. This means that teachers who often struggle with limited tools, facilities, or funding are still able to carry out meaningful project-based tasks without compromising the quality of instruction. By simplifying directions and ensuring that activities can be adjusted to fit varying classroom contexts, the manual guarantees that learners from diverse backgrounds can benefit equally. This accessibility feature directly addresses the equity gap in Industrial Arts education, ensuring that innovation skills are cultivated regardless of the school's resource level.

Usability was ensured through the inclusion of step-by-step project guides that made classroom implementation straightforward. Teachers often face difficulties in shifting from traditional lecture-based methods to hands-on, project-oriented approaches, but the manual's structured format reduces this burden. By providing sequential instructions, clear objectives, and practical activity outlines, the manual allows teachers to confidently facilitate lessons while students can easily follow the process. This usability feature enhances classroom efficiency, minimizes confusion, and ensures that both teachers and learners can focus on the creative and technical aspects of Industrial Arts rather than struggling with unclear procedures.

Interoperability was embedded in the manual by ensuring seamless integration with DepEd-approved curricula and instructional tools. This means that the manual does not function as an isolated resource but rather complements existing frameworks and teaching materials. By aligning with the Learning Resource

Management and Development System (LRMDS) standards, the manual ensures that its content, format, and instructional design are consistent with national guidelines. This interoperability allows teachers to incorporate the manual into their current teaching practices without conflict, thereby strengthening curriculum delivery and reinforcing outcome-based education principles.

Scalability was achieved by designing the manual with the capacity to be reproduced and adapted across different schools and contexts without losing effectiveness. This feature ensures that the manual is not limited to a single institution but can be replicated in various educational settings, whether urban or rural, well-resourced or resource-constrained. Its adaptability allows schools to modify activities according to their specific needs while maintaining the integrity of project-based learning principles. Scalability also supports sustainability, as the manual can serve as a long-term instructional resource that evolves with changing educational demands, thereby promoting consistency and innovation in Industrial Arts education nationwide.

Evaluation of the manual's print material quality confirmed its accuracy, relevance, and alignment with curriculum standards. Teachers and master teachers noted its logical organization, durability, and up-to-date information reflecting industry practices and safety protocols.

Finally, teachers expressed strong acceptance of the manual, recognizing its practicality, relevance, and potential to foster creativity, collaboration, and problem-solving skills. They acknowledged that the manual bridged theoretical knowledge with hands-on practice, making lessons more engaging and meaningful.

Direct Answers to Research Questions

Teachers reported that challenges in teaching Industrial Arts occur “most of the time” or “always,” which confirms their persistence and significant impact on instruction. This finding highlights the systemic nature of the difficulties faced in classrooms, ranging from resource limitations to time constraints and reliance on traditional teaching methods. The frequency of these challenges underscores the urgent need for structured interventions, as they consistently hinder the effective delivery of innovation-focused instruction. By documenting the regularity of these issues, the study validates the necessity of developing a manual that directly addresses them and provides teachers with practical solutions to overcome barriers in their daily practice.

The manual was developed in accordance with the Gold Standard Project-Based Learning framework, successfully integrating its seven essential elements. Evaluators validated that the manual embodies authenticity, inquiry-driven learning, reflection, and student-centeredness. This alignment ensures that learners are not only engaged in meaningful projects but also guided through processes that foster creativity, collaboration, and critical thinking. By embedding these elements, the manual transforms Industrial Arts instruction into a dynamic, learner-centered experience, moving away from rote memorization and passive learning. The integration of Gold Standard PBL principles demonstrates the manual's capacity to elevate classroom practice to global pedagogical standards while remaining responsive to local contexts.

Conformance with the Learning Resource Management and Development System (LRMDS) principles was another significant achievement of the manual. By adhering to accessibility, usability, interoperability, and scalability, the manual ensures adaptability across diverse school contexts. Accessibility guarantees that even resource-constrained schools can implement the manual effectively, while usability provides teachers with clear, step-by-step guides for classroom application. Interoperability allows seamless integration with DepEd-approved curricula, ensuring consistency with national standards. Scalability ensures that the manual can be reproduced and adapted across different schools without losing effectiveness. Together, these principles make the manual a sustainable and context-sensitive resource for Industrial Arts education.

Evaluation of the manual based on LRMDS standards for print materials revealed high ratings in content quality, format, organization, and accuracy. This reflects its reliability and alignment with DepEd standards, ensuring that the manual is not only pedagogically sound but also technically robust. Content quality was validated through its relevance and completeness, while format and organization were praised for their clarity and logical flow. Accuracy was ensured by aligning technical data and safety protocols with current industry

practices. These evaluations confirm that the manual meets professional standards and can serve as a dependable instructional resource for teachers.

Teachers demonstrated strong perceived acceptance of the manual, showing comprehension of PBL principles and recognizing its practicality for classroom application. They agreed that the manual fosters essential 21st-century skills such as creativity, collaboration, and problem-solving. This acceptance indicates that teachers are not only willing to adopt the manual but also see its value in transforming their instructional practices. By validating its relevance and effectiveness, teachers confirmed that the manual bridges the gap between curriculum design and classroom realities, ensuring that learners are equipped with the competencies necessary to thrive in a technology-driven society. This strong acceptance underscores the manual's potential to serve as a cornerstone for innovation-focused education in Industrial Arts.

Contribution to the Field

This study contributes to the field of education by addressing the gap in localized instructional materials for Industrial Arts. By operationalizing PBL principles within the Philippine context, the manual bridges curriculum theory with classroom practice, offering a transformative approach to teaching Technical-Vocational Education (TLE). It affirms the effectiveness of PBL in fostering deeper learning, skill transfer, and student engagement, while also demonstrating how global frameworks can be adapted to local realities.

Moreover, the study highlights the role of teachers as facilitators of creativity and problem-solving rather than mere transmitters of knowledge. It underscores the importance of instructional innovation in preparing learners for employability, entrepreneurship, and real-world challenges.

Policy Recommendations

The findings suggest several policy directions:

Institutional adoption of the manual is critical to ensuring its long-term sustainability and consistency. By integrating the manual into DepEd's official repository of instructional materials under the Learning Resource Management and Development System (LRMDS), it becomes part of the standardized resources available to teachers nationwide. This institutional recognition not only validates the manual's quality but also guarantees that it will be accessible to educators across different schools and divisions. Such adoption ensures that the manual is not treated as an isolated intervention but as a systemic tool embedded within the national framework for instructional innovation. Pilot testing and other PBL seminars could allow the effective implementation and integration of the manual to the educational reforms in the country.

Resource provision is equally important in enabling the effective implementation of Project-Based Learning. While the manual provides structured guidance, its success depends on the availability of adequate facilities, materials, and support systems. Allocating resources such as tools, equipment, and financial support ensures that teachers can carry out projects without being hindered by scarcity. Moreover, institutional support systems—such as administrative backing and time allocation—are necessary to sustain project-based tasks. By addressing resource gaps, schools can maximize the manual's potential and ensure that learners experience authentic, hands-on activities that foster innovation.

Professional development plays a pivotal role in strengthening instructional innovation. Continuous training for teachers in PBL strategies ensures that they are not only familiar with the manual but also confident in applying its principles. Training programs can focus on scaffolding inquiry, managing project milestones, and embedding formative assessment, all of which are essential for effective PBL implementation. By investing in professional development, schools empower teachers to move beyond traditional methods and embrace learner-centered approaches. This ongoing capacity-building ensures that the manual is used to its fullest potential, fostering a culture of innovation in Industrial Arts education.

Collaboration and partnerships further enhance the impact of the manual. Encouraging collaboration among teachers allows them to share best practices, co-develop projects, and support one another in overcoming

challenges. Partnerships with local industries provide students with opportunities to engage in projects that address real community needs, thereby making learning more authentic and relevant. These collaborations bridge the gap between classroom instruction and real-world application, preparing learners for future employment and entrepreneurship. By fostering networks of support, schools can ensure that PBL becomes a dynamic and community-driven approach to education.

Expansion across specializations represents the next step in validating the manual's effectiveness. By replicating and adapting the manual for other Technology and Livelihood Education (TLE) specializations and grade levels, educators can test its applicability in diverse contexts. Whether in Home Economics, ICT, or Agri-Fishery Arts, the principles of PBL can be tailored to suit different subject areas while maintaining their focus on innovation and problem-solving. This expansion not only broadens the manual's impact but also contributes to the overall transformation of TLE instruction, ensuring that students across disciplines benefit from experiential, inquiry-driven learning. In this way, the manual serves as a model for scalable and adaptable instructional innovation.

Practical Implications

The study demonstrates that adopting PBL transforms Industrial Arts classrooms into dynamic spaces for creativity, collaboration, and innovation. Learners gain opportunities to apply technical skills in real-world contexts, preparing them for employability and entrepreneurship. Teachers benefit from structured guidance that reduces reliance on traditional methods and enhances instructional quality. At the institutional level, the manual provides a model for curriculum innovation that can be scaled across schools nationwide.

Limitations of the Study

Despite its contributions, the study has limitations:

Sampling limitations were evident in the study, as it focused exclusively on Grade 8 Industrial Arts teachers within a specific division. While this provided a clear and manageable scope, it also restricted the generalizability of the findings to other grade levels, specializations, or geographic contexts. The experiences and perceptions of teachers in other TLE areas such as Home Economics, ICT, or Agri-Fishery Arts may differ significantly, and the challenges they face could vary depending on subject matter and available resources. Thus, while the results are highly relevant to Industrial Arts in Bulacan, caution must be exercised in applying them broadly without further validation across diverse contexts.

Data limitations also emerged due to the reliance on self-reported survey responses. While surveys are effective in capturing teachers' perceptions and attitudes, they are inherently subject to bias. Teachers' responses may have been influenced by personal experiences, expectations, or even social desirability, leading to potential over- or underestimation of the manual's effectiveness. For example, teachers who are enthusiastic about innovation may have rated the manual more positively, while those accustomed to traditional methods may have expressed reservations. This reliance on perception-based data highlights the need for complementary methods, such as classroom observations or student performance assessments, to provide a more objective measure of the manual's impact.

Methodological constraints were also present, as the study primarily employed quantitative methods to measure acceptance and evaluation. While quantitative data is useful for identifying trends and general patterns, it may not fully capture the nuanced experiences of teachers and learners in implementing PBL. The complexities of classroom dynamics, the subtleties of student engagement, and the challenges of adapting projects to real-world contexts are often better explored through qualitative approaches such as interviews, focus groups, or case studies. Without these perspectives, the study may have overlooked important insights into how PBL is experienced in practice. Future research could therefore benefit from mixed-method designs that combine quantitative rigor with qualitative depth, offering a more holistic understanding of the manual's effectiveness. Moreover, the time constraint led the researcher to forego the initial implementation of the manual and rely on personal assessment of IA teachers who have evaluated the manual first hand.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future studies should:

Expanding the scope of future research to include other TLE specializations and grade levels would validate the effectiveness of PBL manuals across diverse contexts. While the current study focused on Grade 8 Industrial Arts, replicating the manual in areas such as Home Economics, ICT, or Agri-Fishery Arts would provide a broader understanding of how project-based pedagogy functions in different disciplines. This expansion would also allow researchers to determine whether the principles of PBL are universally applicable or require subject-specific adaptations, thereby strengthening the generalizability and relevance of the findings.

Employing mixed-methods approaches in subsequent studies would capture both quantitative data and qualitative insights into teacher and student experiences. While surveys provide measurable indicators of acceptance and evaluation, qualitative methods such as interviews, focus groups, and classroom observations would reveal the nuanced realities of PBL implementation. These insights could uncover how teachers adapt projects to their contexts, how students respond to inquiry-driven tasks, and what challenges emerge during execution. By combining numerical data with rich narratives, future research would offer a more holistic picture of the manual's impact.

Exploring the integration of digital tools and emerging technologies into PBL frameworks would enhance authenticity and relevance in a technology-driven society. Incorporating tools such as design software, simulation platforms, or collaborative online environments could expand the scope of projects and better prepare students for modern industries. Digital integration would also allow learners to engage with real-world problems using contemporary methods, thereby bridging the gap between classroom instruction and workplace demands. This exploration would ensure that PBL remains aligned with the evolving needs of the Fourth Industrial Revolution.

Investigating the long-term impacts of PBL on student outcomes would provide valuable evidence of its effectiveness beyond immediate classroom performance. Future studies could examine how PBL influences employability, entrepreneurship, and lifelong learning competencies, thereby assessing its contribution to students' readiness for real-world challenges. Tracking graduates who experienced PBL-based instruction would reveal whether the skills they developed—such as creativity, collaboration, and problem-solving—translate into tangible success in higher education, careers, or entrepreneurial ventures. Such longitudinal research would strengthen the case for institutionalizing PBL in technical education.

Examining institutional factors such as administrative support and resource allocation would shed light on the sustainability of PBL practices. While the manual provides structured guidance, its long-term success depends on systemic support from schools and educational authorities. Investigating how leadership, funding, and infrastructure influence PBL implementation would identify the conditions necessary for sustaining innovation-focused pedagogy. This line of inquiry would also highlight best practices for institutionalizing PBL, ensuring that it is not treated as an isolated initiative but embedded within the broader educational system.

Final Reflection

In essence, this study affirms that the developed PBL manual for Industrial Arts is a transformative instructional tool that addresses persistent challenges in teaching, aligns with DepEd standards, and fosters essential 21st-century skills among learners. While limitations exist, the manual's strong acceptance by teachers and evaluators underscores its potential to reshape Industrial Arts education. By adopting and scaling PBL practices, schools can cultivate innovation-driven learning environments that prepare students to thrive in a rapidly evolving, technology-driven society.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to their advisers, panel members, participating schools

and teachers, and the Bulacan State University for their support and guidance throughout the completion of this research.

REFERENCES

1. Adilah, N. (2023). Systematic literature review: Project-based learning in English language teaching. *Langue: Journal of Language and Education*, 1(2). <https://doi.org/10.22437/langue.v1i2.24771>
2. Alonzo, R., & Cruz, J. (2024). The role of teaching methods in facilitating skills diffusion in Technology and Livelihood Education (TLE): A study among Bachelor of Technology and Livelihood Education faculty. ResearchGate. <https://www.researchgate.net/publication/391591334>
3. Alvarado, M. (2024). Utilizing project-based learning to improve the learning and innovation skills of Grade 8 TLE-exploratory students in a Philippine public high school. ResearchGate. <https://www.researchgate.net/publication/383269165>
4. Arroz, M. D., Añero, M. B., Loremia, V. Z., Rivas, R. A., Lapiz, G. C., & Marurillas, F. D. (2025). The role of teaching methods in facilitating skills diffusion in Technology and Livelihood Education (TLE): A study among Bachelor of Technology and Livelihood Education faculty. *Journal of Educational and Social Research*, 15(2), 45–58. <https://www.richtmann.org/journal/index.php/jesr/article/view/14301>
5. Bacomo, M. F., & Bustos, J. M. (2021). Project-based learning approach in Technology and Livelihood Education (TLE) and its effect on students' skill development. *International Journal of Education and Research*, 9(6), 45–56. <https://www.ijern.com/journal/2021/June-2021/04.pdf>
6. Bautista, L., & Santos, E. (2023). The impact of the project-based learning method on students' performance in Industrial Arts. ResearchGate. <https://www.researchgate.net/publication/369628184>
7. Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, 83(2), 39–43. <https://doi.org/10.1080/00098650903505415>
8. Berlas, R. D. (2024). Barriers in teaching Industrial Arts for Grade 11 (Division of Tacloban City, Leyte) [Descriptive qualitative study]. ICCEPH. <https://www.icceph.com/wp-content/uploads/2024/09/BARRIERS-IN-TEACHING-INDUSTRIAL-ARTS-FOR-GRADE-11.pdf>
9. Bernas, R. (2024). Project-based learning approach, productive competence, and learning engagement of the Bachelor of Technical-Vocational Teacher Education (BTVTED) students. *International Journal of Education and Research*, 3(2), 76–89. <https://www.researchgate.net/publication/382219590>
10. Cerasoli, C. P., Nicklin, J. M., & Ford, M. T. (2014). Intrinsic motivation and extrinsic incentives jointly predict performance: A 40-year meta-analysis. *Psychological Bulletin*, 140(4), 980–1008. <https://doi.org/10.1037/a0035661>
11. Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer. <https://doi.org/10.1007/978-1-4899-2271-7>
12. Department of Education. (2023). General shaping paper – Technology and Livelihood Education (TLE). Republic of the Philippines. <https://www.deped.gov.ph/wp-content/uploads/GENERAL-SHAPING-PAPER-2023.pdf>
13. Department of Education. (2023, August). MATATAG K to 10 curriculum: EPP/TLE (Grades 4–10). https://www.deped.gov.ph/wp-content/uploads/MATATAG-EPP_TLE-CG-2023-Grades-4-10-1.pdf
14. Department of Education – Cordillera Administrative Region. (2025, February 18). RM No. 123, s. 2025 – Mapping of Grades 9 and 10 Technology and Livelihood Education (TLE) sectors in the Revised K–10 Curriculum. <https://m.depedcar.ph/regional-memoranda/rm-no-123-s-2024-0>
15. Dewey, J. (1938). *Experience and education*. Macmillan. <https://archive.org/details/experienceeducat00dewe>
16. Dullente, J., & Namoco, S. (2024). Utilizing project-based learning to improve the learning and innovation skills of Grade 8 TLE-exploratory students in a Philippine public high school. ResearchGate. https://www.researchgate.net/publication/383269165_Utilizing_Project-Based_Learning
17. Eslit, E. R. (2023, July 24). Charting the future of Philippine education: Navigating the intersection of K-12 education, the Fourth Industrial Revolution (IR 4.0), and internationalization [Preprint]. Preprints. <https://www.preprints.org/manuscript/202307.1578/v1>

18. *Frontiers in Psychology*. (2023). Project-based learning and its impact on students' thinking skills and attitudes: A systematic review. *Frontiers Media SA*.
<https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1202728/full>
19. *International Journal of Innovative Science and Research Technology (IJISRT)*. (2025). Activity-based and project-based teaching approaches for practical and entrepreneurial skill development in TLE classrooms. <https://www.ijisrt.com/assets/upload/files/IJISRT25AUG1442.pdf>
20. Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, 19(3), 267–277. <https://doi.org/10.1177/1365480216659733>
21. Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall. <https://learningfromexperience.com/downloads/research-library/experiential-learning-theory.pdf>
22. Lavado-Anguera, S., Velasco-Quintana, P.-J., & Terrón-López, M.-J. (2024). Project-based learning (PBL) as an experiential pedagogical methodology in engineering education: A review of the literature. *Education Sciences*, 14(6), 617. <https://doi.org/10.3390/educsci14060617>
23. Liu, M., Horton, L., & Toprac, P. (2011). Students' creativity and problem-solving skills through project-based learning. *Interdisciplinary Journal of Problem-Based Learning*, 5(2), 1–20. <https://doi.org/10.7771/1541-5015.1254>
24. Llego, M. A. (2021). Implementation of project-based learning in TLE woodworking class. *International Journal of Trend in Scientific Research and Development*, 5(4), 1421–1426. <https://www.ijtsrd.com/papers/ijtsrd42466.pdf>
25. Manlangit, M. J. F. (2025). Exploring the teachers' challenges in the delivery of the TLE curriculum in Northern Samar, Philippines. *International Journal of Research Studies in Education*, 14(1), 23–37. https://consortiacademia.org/wp-content/uploads/2023/v14i12/25180_final.pdf
26. McCarthy, M. (2010). Experiential learning theory: From theory to practice. *Journal of Business & Economics Research*, 8(5), 131–139. <https://doi.org/10.19030/jber.v8i5.725>
27. McLeod, S. (2023). *Simply Psychology*. <https://www.simplypsychology.org/self-determination-theory.html>
28. Montoya, R., & Javier, R. (2020). Project-based instruction in Industrial Arts and its impact on students' craftsmanship. *LPU-Laguna Journal of Multidisciplinary Research*, 4(1), 120–132. <https://lpulaguna.edu.ph/wp-content/uploads/2020/09/7-Montoya-and-Javier.pdf>
29. OECD. (2018). *The future of education and skills: Education 2030*. OECD Publishing. <https://www.oecd.org/education/2030-project/>
30. Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, 25(1), 54–67. https://www.selfdeterminationtheory.org/SDT/documents/2000_RyanDeci_IntExtDefs.pdf
31. Sagita, S., Rahmat, A., Priyandoko, D., & Sriyati, S. (2023). Sustainability of project-based learning: Challenge and obstacles from students' perception point of view. *Jurnal Penelitian Pendidikan IPA*, 9(2), 810–816. <https://doi.org/10.29303/jppipa.v9i2.3044>
32. Sánchez-García, R., & Reyes-de-Cózar, S. (2025). Enhancing project-based learning: A framework for optimizing structural design and implementation — A systematic review with a sustainable focus. *Sustainability*, 17(11), 4978. <https://doi.org/10.3390/su17114978>
33. Silma, N., Maulida, I., Wulan, A. P., Merawati, J., & Hasan, M. K. (2024). A comprehensive review of project-based learning (PBL): Unravelling its aims, methodologies, and implications. *Journal of Education, Social & Communication Studies*, 1(1), 10–19. <https://ojs.ptmj.com/index.php/JESCS/article/view/3>
34. Thomas, J. W. (2000). *A review of research on project-based learning*. Autodesk Foundation. https://tecfa.unige.ch/proj/eteach-net/Thomas_researchreview_PBL.pdf
35. Tongol, K. M., & Namoco, S. (2025). Discrepancy between theoretical instruction and practical skills in Industrial Arts. *Journal of Vocational Education and Training*, 71(4), 512–528. <https://www.researchgate.net/publication/392748322>
36. *We Think Digital Philippines*. (2021). *Primer on project-based learning (PBL)*. <https://wethinkdigital.fb.com/learning/ph/wp-content/uploads/sites/38/2021/10/Primer-on-PBLpdf.pdf>