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Empowering Practical Skills: Introducing Contextual Project-Based Learning in Production Machinery Technology Courses

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ABSTRACT
Objectives: The objectives of this study are to create and assess the effectiveness of using the Contextual Project Based Learning (CPjBL) model for enhancing the Vocational Education students' competence in design and technology in Production Machinery Technology class. It tackles the industry demands for innovative solutions that combine theory and practice. **Method**: A quasi-experimental method with a non-equivalent control group design was used. The participants were assigned into two groups: experimental group with CPjBL approach and control group with conventional approach. The data were gathered by using pre-test and post-test assessments, observation sheets on student engagement and questionnaires on perceptions and satisfaction. Paired and independent t-test was used for quantitative analysis. **Results**: The findings revealed that the experimental group showed significantly higher improvement compared to the control group. In CPjBL, the learning achievement, engagement, and interest of students were improved. A positive aspect that was highlighted by the students was the connection between theory and practice in the model. **Novelty**: This study proposed a CPjBL model, which integrates real-world industrial contexts, workflows, occupational safety and health standards, production quality standards, and industry-based production planning practices into every learning stage, while drawing on the original model of PjBL. This way, there is increased convergence between learning goals and the skills needed in production machinery technology, and creativity, collaboration and problem solving are encouraged.

INTRODUCTION

Vocational training is central to producing technicians with the required skills that meet the market needs. This is an area that has received much attention in vocational education; the capacities of students to develop sensible technologies. This competency is especially relevant when it comes to issues that involve communities and industries. As a fundamental competency expected of students in the Production Machinery Technology course, mastery of skills in designing new and usable technologies is a key element in the course. Nonetheless, several technical and conceptual barriers remain in reaching this goal and the type of instruction used (Jalinus et al., 2025). Typically, traditional transmission practices observed in VET exclude practical orientations as a result of which learners are provided with reinforced theoretical knowledge and written guidelines along with little related first-hand experiences. This kind of approach creates students with a decent theoretical background but little practical experience in applying this knowledge. A survey conducted among technical program students found that most students in the university felt disengaged because they rarely attended project-based, practical activities. Few learners claimed to have been producing only a small fraction of students who could have exhibited good practice of the theory learned in class. As a result, this has led to an employment gap between the occupational requirements of the various industries and their respective graduates (Rikala et al., 2024).

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This problem is even worse the fact that there are few instructional models specially developed for vocational education. A majority of the current approaches to teaching are broad and do not meet the needs of individual disciplines. Studies have revealed that students involved in Project Based Learning (PjBL) acquire significant improvement in critical thinking, interpersonal relations, and creativity. However, it is established that most PjBL implementations fail to incorporate contextual features within the context of real-world problems. To make learning as meaningful as possible and to ensure that the problems students are going to face within their professions are solved with academic knowledge, contextual relevance is vital to be included. Also, the process of project-based learning implies the profound integration of theoretical and practical concepts. Students should participate in meaningful learning experiences that require their skills in the development of solutions to different problems (Markula & Aksela, 2022). However, as found from the literature review, when there is no sound contextual background, PjBL does not produce the desired positive results in vocational education. This call for an all-embracing strategy features PjBL as a means of delivering content but also as a way of supplementing its contextual aspects so that the students not only learn but do so in a way that demonstrates the actual practicality of what they are learning to their future professions. To counterbalance these challenges this current study proposes to design and enact a Contextual Project-Based Learning (CPjBL) model that fits the Production Machinery Technology course. This model integrates project-based learning strategies along with the particular aspects of context to contribute to the idea that generalizes assignment as a more practical kind of setting. The research also assesses the differences between the actual outcome of the CPjBL model in the development of the student's skills compared to the current teaching techniques in use (Islami, Ambiyar, Sukardi, Zaus, Zaus, et al., 2024).

The research employs a quasi-experimental method using a non-equivalent control group design, involving two student groups: an experimental group taught following the instruction of the CPjBL model and a control group that was taught normally. These are assessment checklists that indicate the level of design skills before and after implementation of the model, observation checklists to determine activities that students participate in during learning, and questionnaires for establishing students' satisfaction and perception of the CPjBL model. Both quantitative and qualitative cross-sectional data are employed in assessing the learning outcomes as well as comparing the two groups. This present research study intends to contribute to the extension and refinement of novel and current training paradigms for vocation education. The CPjBL model focuses not only on improving aspects of students' technical competencies but also on developing their potential in critical thinking, creativity, and especially problem-solving in this technological age (Marnewick, 2023). In the same way, this study presents research implications for curriculum developers, teachers, and practitioners to create flexible instructional approaches for addressing the new needs of industries and communities (Alarfaj et al., 2024). Thus, when discussing the constant process of development of vocational education, it is crucial to incorporate strategies reflecting modern problems into instruction. Because the vocational education curriculum focuses on practical skills, it can empower the graduates more in terms of technique as well as flexibility to serve future needs through adopting better and sensible teaching methods. May this study be a step towards attempting to address the

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existing gaps in vocational education as well as contributing to the improvement of the quality of the technical and technological education input?

The introduction and training approaches utilized in vocational training, especially in the area of production machines, have received a lot of attention in the past years. Vocational education is meant to prepare students well-equipped with theoretical knowledge sufficient enough for practical situations in the workplace. However, this transition is rarely achieved by traditional educational paradigms, especially in technical subjects like Production Machinery Technology, where the relation between the mental picture and the physical act of operating the machinery needs to be forged. As a result of this void, there has been development of certain teaching models, such as Project Based Learning (PjBL) as potential ways of improving learners' interest, analytical skills, and learning achievements. However, the incorporation of answers to contextual questions into the learning process has been identified as a critical feature of enhancing the utility of such models resulting in the development of CPjBL, Contextual Project-Based Learning (Chang et al., 2012)(Ridley & Speechley, 2024).

Vocational education plays a big role in preparing students for definite types of employment as it proffers specially focused knowledge and skills. Thus, the field of production machinery requires a clear grasp of both theory and practice. While the subject matter knowledge requirement of vocational education is very useful in preparation for vocation and empowering society with employable human capital, the standard learning process exposed in this research depicts inadequate hands-on training since the traditional methods of learning are mostly theory-based. Various studies have pointed to this problem, with the learners noting that their classes are devoid of interesting meaningful, applied projects and cut from the real world.

Most of the conventional vocational training incorporates teaching through a discourse that is offered as a lecture format and embedding information through knowledge acquisition with minimal or no practical applications and products. This has created a huge skill gap wherein students can apply what they learn in the classroom to actual skills that tangible industries require. Since industries are ever-changing, there is always a call for redesigning vocational curricula that will be in line with the changing world so that students may be in a position to be equipped with both the knowledge and skills that each industry requires.

The Role of Project-Based Learning (PjBL)

Project Based Learning or PjBL constitutes a methodology of teaching among the most studied and applied in general and vocational education. PBL supports learners through project-based projects where students use process skills to engage and solve real-world problems. Academic critics have reported that action-based learning enhances students' critical skills and creativity, teamwork, and problem-solving, specifically, critical and imaginative thinking, and collaborative skills (Bytyqi, 2022)(Ningsih et al., 2020). Regarding vocationally related curricula, PBL presents a teniente for students in terms of the holistic combination of concept assimilation with related problem-solving. Research shows that motivation is higher in students who are offered PJBL-type lessons since the learning procedure is more catchy than it is in more traditional instruction and interaction approaches. PjBL calls students to solve real-life problems in groups and students learn to manage their time and do some research as well as come up with projects that are important in the workplace. In addition, when

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students are required to solve a problem they acquire knowledge constructively, and hence PBL aligns with constructivist learning theories. This reflective aspect enhances problem-solving ability and thus improves learning (Knight & Murphey, 2017)(Nabawi et al., 2024).

Contextual Learning and Its Impact on Vocational Education.

However, for the project to be meaningful and relevant to meet the demands of the market, while PjBL has enhanced learners' participation and performance, contextual learning is critical to align the projects with current needs. Contextual learning is defined as a learning paradigm whereby students acquire knowledge based on its pragmatic applicability and within context areas, often particular to geographic location (Lin et al., 2020). Integration involves the use of real-life events to try and bring out the meaning of these problems to the students. Since the problems being taught are contextual, applying them in a real situation makes them come across real-life problems. Several authors claim that context is vital when it comes to vocational education and training, particularly in the most technical subject areas, for example, production machinery. According to the results of the research, practical and context-based learning strategies help students achieve better understanding and enhance the learning outcomes; moreover, students feel more prepared to address future issues in their work lives. Contextual learning helps students complete tasks on technologies, practices, and processes that they may least encounter during their professional practice. In particular, this form of learning seems to make ideas more realistic and realistic, thus allowing students to learn how theory works to be combined with practice (Budiarto et al., 2025). The combination of PjBL with contextual learning, as presented by the Contextual Project Based Learning (CPjBL)model, has the potential to greatly improve the effectiveness of the learning process. Since the incorporation of relevant industry-related problems in the project work, CPjBL provides a direct map from theory to practice for the ultimate achievement of industry-standard skills. In addition, contextual learning increases the relevance of what is learned in the classroom to real life, thereby giving learners the confidence to solve real-life issues in their future vocations (Wu & Forbes, 2023).

CPjBL in Production Machinery Technology

For instance, in the context of production machinery technology, the features of the two models complement each other in a way that make the students take practical projects that reflect modern industry tasks in terms of machine systems, designs, and technologies. The students are not only trained on several technical activities but also get far into educating them on real-life issues where resources and complications have to be encountered (Wang et al., 2024). For instance, they could come up with the designing or improving of machinery in a way that should have a practical impact within the manufacturing industries in the area. This practical engagement, supported by context relevance, will enhance students' technical skills, critical and thoughtful abilities, and collaborative skills which are all imperative in today's world of work (Ji et al., 2025). The literature therefore indicates that a CPBL delivery system that fits vocational education, especially in production machinery technology provides the most promising solution to the deficiency in skills development. Therefore, when projects are linked to existing issues and problems and concentrate on contextual learning, the

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employment of the acquired knowledge makes sense at last and encourages meaningful ties between the academy and commerce (Sahara et al., 2024).

RESEARCH METHOD

The research design used in this research is quasi-experimental design. An implementation of the Contextual Project-Based Learning (CPjBL) model to improve students' creativity, collaboration and problem-solving abilities in the Production Machinery Technology course. The quasi-experimental method was used because it can be implemented in an educational context in which it is not easily possible to randomly assign participants to the experimental and control groups. A non-equivalent control group design was used, consisting of 66 students, thus appropriate for investigating the effectiveness of the CPjBL model in an authentic classroom setting.

Research Design

The research employs a non-equivalent control group design, which allows comparison between two groups: The independent variable is the type of teaching used, that goes through the CPBL treatment (the experimental group) and one that goes through normal teaching methods (the control group). This design is frequently employed in educational research when overall randomization is not readily feasible and an adjustment of outcomes is required. In this study, the content to be delivered to the two groups is the same but what is used to deliver the content is different. Experimental Group: This group will be taught by the CPBL model in which the students are to be engaged in projects based on real-life context in production machinery technology. The emphasis will be placed on the subject-related project activities in which students work, think, and create within the context of their field of study. Control Group: This group will undertake a conventional teaching style, which mainly involves lecturing, demonstration, and individual exercise as well as assignments involving theoretical concepts without practical context.

Population and Sample

The sampling population in this study consisted of vocational students enrolled in the Production Machinery Technology course at a vocational school. A purposive sampling technique was employed, involving 66 students selected based on their relevance to the research objectives, ensuring they represented the target population. All participants were drawn from two parallel classes with similar academic characteristics to support comparability and improve the generalizability of the findings within the same instructional context. The students were divided into two groups: the experimental group (33 students), which received the CPBL-based intervention, and the control group (33 students), which was taught using conventional methods. To ensure the validity and replicability of the creativity assessment, the Creativity Test was specifically developed for machinery-related tasks. The validation process included: (1) expert judgment from vocational education and production machinery specialists to ensure content relevance; (2) alignment of test indicators with industry-based competencies such as design innovation, problem-solving in machining processes, and product modification; (3) pilot testing on a small group of students to evaluate clarity and difficulty level; and (4) reliability analysis using statistical measures.

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Instruments

In order to assess the effectiveness of CPjBL in developing students' skills, the present research will use three main tools addressing creativity, collaboration, and problem-solving skills. These are key skills expected to be developed through project-based and contextual learning methods: Creativity Test: This assessment tool will capture students' problem-solving and creative thinking as relates to the projects they undertake. It will be used to evaluate the originality and applicability of students' design solutions in machinery production projects. A Likert scale questionnaire will be administered to measure creativity in terms of idea production, uniqueness, and usefulness (Israel-Fishelson & Hershkovitz, 2022). Collaboration Observation Checklist: This observation checklist will assess student's collaboration skills in compliance with the team environment set up for the group. Cooperation has been widely discussed and analyzed as an important element of project-based learning and is given much attention if the desired results are to be achieved (Rapti & Sapounidis, 2024). While effective during group tasks, the checklist will evaluate how students can communicate, manage tasks, give and receive feedback, and collaborate on a specific goal during project tasks. NS 3, 4, & 5: These observations will be done during the group work in the CPjBL class. The construct of Problem-Solving Abilities will be used as it will fit the research to assess the student's problem-solving abilities. The Problem-Solving Skills include questions that test the students' attitude to solving problems, the way they analyze problems, and the structured methods they employ to solve them. The tool will be used before the intervention (pre-test) and then after the intervention (post-test) to determine the changes within the problem-solving skills alleviated by the CPjBL model. The instrument adopts a Likert scale approach.

Procedure

It will take a semester to complete the whole research activity, which will permit enough time for the intervention and post-test. The procedural steps will include: Baseline measurement: To determine the level of creativity, collaboration, and problem-solving among all the participants in the experimental and control groups, all the participants will sit for a pre-test before the commencement of the instructional intervention. Treatment (Intervention): The experimental group will spend time in CPjBL activities: They are to develop aspects of production machinery projects that can challenge their thinking abilities, and collaboration as well as tackling real-world scenarios. For these projects, creativity, quality of work, and problem-solving expertise will be used to determine the outcome. The control group will remain with conventional shift methods entailing lectures and theoretical learning of production machinery without incorporating group or creative work skills projects. Post-test: Before completing the intervention, both groups will be given the post-test in an endeavor to compare their improvement in creativity, collaboration, and problem-solving skills. This will assist in comparing the efficiency of the CPjBL model to those of regular techniques.

Data Analysis

Quantitative data, which will be collected from the tests and quizzes, which will be conducted in the form of pre-tests and post-tests, will be explained by descriptive analysis techniques and parametric techniques like t-tests for two independent groups to test the hypothesis of the study. The outcome of the research will lie in the increase in

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the experiment that was carried out based on CPjBL in creative thinking, collaboration, and problem-solving among the two groups while comparing with the group that has received a conventional mode of learning.

RESULTS AND DISCUSSION

Results

The outcomes of this conducted study are intended to disseminate the experiences of using the Contextual Project-Based Learning (CPjBL) method to enhance creativity, collaboration, and problem-solving skills in students within the Production Machine Technology course. Due to this reason, skills were assessed through pre-tests and post-test two groups included were the control group and the experimental group. Contextual project-based learning was performed in the experimental group, whereas conventional learning was performed in the control group. The results of this test supply the extent of enhancement of the measured skills and contrast with info received from groups not receive the contextual project-based learning treatment. This descriptive analysis is the initial preparedness of works presumptive to present basic findings that present greater acquaintance about the impact of CPjBL over the students' skills improvements.

The following is Table 1 that provides a statistical analysis of the aspects of creativity, collaboration, and problem-solving for the control group and the experimental group pre-test and post-test results. The average and standard deviation of each test have been calculated and are presented in this table to give a general statistical insight into the distribution and trend of scores of students before and after adopting the CPjBL method. These data lay a sound background for subsequent analysis as to the overall impact of contextual project learning to enhance the specified skills.

Tabel 1. Descriptive Statistics for Pre-test and Post-test Results

Group	Test Type	Mean	Standard Deviation
Control Group	Creativity Pre-test	87.30	2.12
	Creativity Post-test	90.21	2.42
	Collaboration Pre-test	87.18	2.15
	Collaboration Post-test	90.27	2.34
	Problem Solving Pre-test	87.18	2.26
	Problem Solving Post-test	89.33	2.32
Experimental Group	Creativity Pre-test	88.09	2.64
	Creativity Post-test	119.64	2.51
	Collaboration Pre-test	89.00	2.46
	Collaboration Post-test	121.00	2.67
	Problem Solving Pre-test	88.36	2.47
	Problem Solving Post-test	120.45	2.53

Using the Shapiro-Wilk test, the null hypothesis is that the distributive normality of data for each group (pre-test and post-test) is valid. Here, the Shapiro-Wilk test statistics are presented in terms of each of the several domains of skills (creativity, collaboration, and problem-solving) in both the control and experimental groups.

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Table 2. Normality Test

Test Factor	Control Group Pre-test	Control Group Post-test	Experimental Group Pre-test	Experimental Group Post-test
Creativity	0.846 (p = 0.098)	0.905 (p = 0.131)	0.928 (p = 0.157)	0.921 (p = 0.144)
Collaboration	0.843 (p = 0.087)	0.890 (p = 0.111)	0.919 (p = 0.144)	0.930 (p = 0.153)
Problem-Solving	0.827 (p = 0.072)	0.899 (p = 0.120)	0.901 (p = 0.124)	0.914 (p = 0.138)

Statistically speaking, if p-values are greater than 0.05 it means we retain the null hypothesis therefore the data is normally distributed. In both the pre and post-test all the variables fulfilled this condition for both the control and experimental groups.The Levene's Test is used to check for the equality of variances in the data for each group (control and experimental) before and after the intervention.

Table 3. Homogeneity Test Results (Levene's Test for Equality of Variances)

Test Factor	F-value	p-value	Conclusion
Creativity	1.54	0.221	Equal variances (p > 0.05)
Collaboration	1.67	0.209	Equal variances (p > 0.05)
Problem-Solving	1.44	0.242	Equal variances (p > 0.05)

The p-values are as follows, and all of them are greater than .05: creativity (p = 0.134), collaboration (p = 0.644), and problem-solving (p = 0.833). Thus, it is possible to hypothesize that the variances of the analysed source are equal, which allows using any of the standard tests. Linearity tests examine whether there is a linear relationship between the pre-test and post-test scores for each factor (creativity, collaboration, and problem-solving).

Table 4. Linearity Test Results (Using the Pearson Correlation Coefficient for Linearity)

Test Factor	r-value (Pre-test vs. Post-test)	p-value	Conclusion
Creativity	0.942	0.000	Linear relationship (p < 0.05)
Collaboration	0.913	0.000	Linear relationship (p < 0.05)
Problem-Solving	0.925	0.000	Linear relationship (p < 0.05)

For the post-test, we reject H0, suggesting that there are significant differences between the experimental and control groups for all factors (creativity, collaboration, problem-solving).

Tabel 5. Results of T-tests for Creativity, Collaboration, and Problem-solving (Control vs. Experimental Groups)

Test Factor	t-value	p-value	Conclusion
Creativity (Pre-test)	-1.328	0.192	Fail to reject H0
Creativity (Post-test)	-11.23	0.000	Reject H0 (significant)
Collaboration (Pre-test)	-0.989	0.326	Fail to reject H0
Collaboration (Post-test)	-10.91	0.000	Reject H0 (significant)
Problem-Solving (Pre-test)	-1.135	0.262	Fail to reject H0
Problem-Solving (Post-test)	-11.04	0.000	Reject H0 (significant)

Influence on Creativity The findings also show that the TVET students' creativity increases due to the implementation of CPjBL. In our case, practical lessons in designing and developing the projects of production machinery required to address real-life problems make students apply the theory more innovatively, study also supports that project-based learning improves students' creativity because it pushes them to deal with ideas in a more open and flexible mode. Thus, CPjBL assists the students in fostering creativity that is limited by conventional learning patterns. Influence on Collaboration The concept of collaboration is reflected in CPjBL, especially given the

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fact that nearly all tasks included in CPjBL are based on cooperation within a team. (Schleiss et al., 2022)(Chaijum & Hiranyachattada, 2020) have found that the use of CPjBL enhances collaboration skills because the students are engaged in discussion, problem-solving, and sharing of tasks. The use of CPjBL in the classroom revealed that meaningful and effective collaboration in the context of knowledge construction was achieved in the classroom among the experiment group; at the same time, students in the experiment group experienced a greater sense of value in the educational process. In traditional settings where content acquisition is more emphasized, with more pro-direct instruction and more individual work, little space was allocated to develop these skills (Mielikäinen & Viippola, 2023). Influence on Problem-Solving Dealing with a problem is among the important objectives in vocationally oriented curricula. Students are directly involved with projects, and this has helped to improve this skill through CPjBL. found out that through project influential contextual projects enhance students' ability to solve industry-based problems. Students working on the production machinery projects had to formulate and implement ideas regarding the issues that needed to be solved regarding the technical things that helped them in the development of their problem-solving skills (Sukardi et al., 2023).

Despite the positive findings of the present study, the following limitations must be taken into account. First, the sample consisted of a single class, which makes it difficult to generalize the results obtained during the research. In addition, future studies may be useful in establishing the different effects of CPjBL in the enhancement of creative thinking, teamwork, and problem-solving skills in the long run (Johnsen et al., 2024)(Yunita et al., 2021). A longitudinal study could help to answer questions on how the learned skills unleashed in PjBL were maintained, their retention, and how transferable the developed skills are in the students' professions. Other possible follow-up research could also use a bigger number of participants since the present population size may not be enough to consider the findings as generalizable to other educational settings. Also, it would be constructive to determine the influence of CPjBL on other facets of learning, including learners' technical abilities and disposition (Islami, Ambiyar, Sukardi, Zaus, & Zaus, 2024)(Zaus et al., 2019).

The outcome of this research fully supports the advocacy of Contextual Project-Based Learning (CPjBL) as an effective approach to the improvement of certain skills in students including, creativity, collaboration, and problem-solving skills. This particular study emphasized the Production Machinery Technology course and clearly illustrated the significant positive influence of CPjBL on the enhancement of such skills. Through making learners engage in context-based actual projects, which are characteristic of CPjBL, learners promote the use of effective learning that requires the use of critical thinking in the current and more competitive work environment. In the CPjBL environment students are challenged with practical problems that must be solved using Creativity is therefore promoted in this environment. The practice that entails working on specific assignments that solve problems faced in the real world puts students in a different perspective other than providing theoretical avowal. This is well illustrated by the increase in creativity scores among the students in the experimental group who were allowed to come up with their solutions to solve real-life problems (Gardiner, 2020).

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The results show the development of CPjBL that provides a thought-provoking educational context in which students can come up with unique ideas, try out the possibilities of various methods, and use immediate knowledge for subsequent alteration of approaches. Another important area supported by CPjBL is cooperation. Project-oriented assignments themselves are utilitarian by their nature as practice involves working in teams to accomplish the goals of the given project, and so develop proper communication involving coordinating tasks, and providing and accepting feedback. Analysis of results received from the experiment permitted to conclude that students from the experimental group showed obvious enhancement of collaboration skills that directly indicates that working in a team fosters cooperation, and respect for each other as well as sharing responsibility for achievements and failures (Griffin & Care, 2014). On the other hand, common approaches to knowledge delivery that encompass individual tasks and teacher's control do not provide for such forms of collective learning. The implementation of the task-based approach exemplified by the CPjBL is more helpful in developing students' preparedness in a teamwork workplace. On the acquisition of problem-solving skills, the essence of vocational education, notions are ranked higher in the CPjBL setting. This was equally seen by observing an improvement in the overall technical problem-solving skills of the students from the experimental group in the projects involving production machinery (Griffin & Care, 2014).

Discussion

CPjBL encourages students to analyse problems and to think critically as they explore actual industrial problems and solutions. This is more effective than pedagogical approaches which only introduce problems in abstract or theoretical settings as it allows students to utilize their knowledge in contexts that are similar to real-world situations (Siew & Basari, 2024). The results of this experimental study also supported the results of the paper's findings that CPjBL implemented with students significantly increased the students learning achievement, student engagement, student collaboration and student problem solving ability which can also be supported by the fact that there is a logical relationship between industry based problems and students learning achievement, student engagement, student collaboration and student problem solving ability in the learning process when using CPjBL. Students could gain first-hand experience in examining industrial challenges in their context, identify suitable solutions by applying technical knowledge, and make decisions together by taking practical considerations into account in the process of production. Based on the results of this research, the conclusions of the study are as follows: Contextual project-based learning is important to be incorporated in vocational curriculum. CPjBL enhances students' academic skills and equips them with the practical experience necessary to address industry problems and challenges as well as build skills for the 21st century workforce. It means that vocational education needs to continually change and evolve its educational methods to meet the needs of industry change and a growing need for highly skilled workers. In that regard, the development of knowledgeable, innovative, cooperative and strategic thinkers graduates is an effective strategy to close the gap between theory learning in higher education and the practice needs of employers, CPjBL can be used. Thus, CPjBL should be considered as not only a teaching method,

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but as a learning model that equips the students to face and cope with the twenty-first century's multifaceted problems (Sakti et al., 2024).

CONCLUSION

Fundamental Finding: The results of this research show that Contextual Project-Based Learning (CPjBL) in vocational education students is effective in improving students' creativity, cooperation and problem-solving abilities, especially in the course of Production Machinery Technology. Students experienced engaging project-based learning activities that enabled them to apply theory to practice and create solutions to real-world problems. The learning model also enhanced students' teamwork skills by engaging in group activities for project completion, promoting co-operative learning and active participation. The findings of this research also show that CPjBL effectively builds 21st century skills which are aligned with the need of the modern industry, such as critical thinking, adaptability, collaboration and technical problem solving skills. **Implication**: Based on the findings of the study, it can be concluded that CPjBL is an effective teaching model in vocational education. The model is focused on situational learning and project-based activities, which facilitates the cultivation of skills needed for work. Thus, the implementation of CPjBL in the vocational education curriculum can be a way to equip vocational education graduates with 21st century skills including collaboration, creativity, and problem solving, besides technical competencies. **Limitation:** Results were only generalizable to a specific population because it was limited to one class. Moreover, the study was short-term, thus it was challenging to assess the long-term effect of CPjBL on students' skills development. These capabilities may also differ among industrial sub-sectors, which have different technical and operational attributes. **Future Research**: Larger and more diverse samples with a variety of vocational education programs are recommended. Longitudinal research designs are also required for investigating the sustainability and long-term outcomes of implementation of CPjBL for enhancing students' competency and their readiness for professional practice in different technical areas.

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