

Assessing the Effect of Project-Based Learning on Managerial Skills in Relation to Student Creativity

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Abstract

Enhancing managerial skills and creativity is crucial for students in technical fields in the rapidly evolving industry. This study explores the impact of project-based learning (PBL) on students' managerial skills and creativity in CNC machining engineering. The research employs a factorial exposure design, focusing on three key variables: project-based learning as the independent variable, managerial skills as the dependent variable, and creativity as a mediating variable. Data were collected using a Likert scale and analyzed through linear regression techniques. The research involved two classes from grade 11 in the machining engineering department of SMK YPI Darussalam 1 Cerme, which engaged in PBL activities. The findings reveal that project-based learning significantly influences students' managerial skills and creativity. While PBL's effect on managerial skills remains substantial, even when creativity is considered a mediating variable, creativity itself does not significantly mediate this relationship. This suggests that while PBL effectively enhances managerial abilities, it also promotes creativity in students, contributing to a richer educational experience. These results highlight the effectiveness of PBL as a pedagogical approach in the CNC machining curriculum. Although creativity does not moderate the relationship between PBL and managerial skills, PBL is valuable in developing both technical skills and creative potential, thus preparing students to meet future industry challenges effectively.

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INTRODUCTION

Vocational education in secondary schools has a very important role in preparing students for the workforce [1]. This educational program aims to develop the practical skills needed in various fields of industry and commerce so that students are ready for work immediately after graduation [2]. This method not only allows students to be more active and creative in solving real problems but also prepares them for the world of work by providing relevant practical experience. The influence of project-based learning on managerial skills is significant, as through these projects, students are trained to develop abilities such as leadership, teamwork, and conflict resolution [3].

While vocational education plays a key role in preparing students for the workforce, there are still significant challenges in integrating practical skills with the managerial skills and creativity required in a rapidly changing industrial environment. Many vocational education programs are still focused on the technical aspects without giving enough emphasis to the development of managerial skills and creativity

that are needed in today's world of work. This gap has the potential to reduce the effectiveness of educational programs in preparing students to face the demands of industry, which increasingly emphasizes the ability to innovate and lead in complex situations.

In the modern industrial era, the technical skills associated with CNC (Computer Numerical Control) technology play a very important role in ensuring the effectiveness and efficiency of the production process. CNC technology not only involves an in-depth understanding of mechanics and machining techniques, but it also requires knowledge in the fields of informatics, electronics, and mechatronics. These skills include mastery of programming software, electronic hardware settings, and integration of complex automation systems. PBL has been identified as an effective method of developing these skills. Through PBL, students not only learn the theory but also apply it in real-life situations, which involve CNC programming, machine tuning, as well as designing electronic control systems. This study aims to explore how PBL affects students' managerial skills and creativity in the field of machining engineering, especially in the context of CNC. These skills include abilities in project planning, organizing, and conflict and team management, which are essential for success in an increasingly complex and automated manufacturing industry.

These managerial skills are crucial for vocational school students because they often jump right into the workforce after graduation, where the ability to manage tasks, communicate effectively, and lead teams is highly valued by the industry [4]. Managerial skills include abilities in planning, organizing, time management, teamwork, problem-solving, and decision-making [5][6][7]. All of these aspects are important in the execution of projects, as they allow students to manage their tasks effectively, work collaboratively, and face challenges with creative solutions. In addition, good management also gives students the opportunity to evaluate and reflect on their performance, receive constructive feedback, and continuously develop their abilities. Thus, managerial skills not only help students complete projects successfully but also facilitate the development of their creativity, which is crucial in an ever-evolving and innovative world of work. Therefore, this study aims to explore the extent to which managerial skills affect the success of PBL implementation and the development of creativity of vocational school students.

One of the main problems is the lack of a learning approach that is able to integrate practical skills with critical, creative and managerial thinking skills. Demonstration teaching methods are often insufficient to develop students' creativity and managerial skills, which are crucial in facing the challenges of the ever-evolving world of work. In addition, good managerial skills are necessary to ensure that students can assess and improve their own work, which is a key aspect in improving performance and productivity in the workplace [8]. In this context, the author believes that PBL offers a significant potential solution. PBL not only facilitates the development of technical skills through real-life, relevant projects but also encourages students to develop critical, creative, and managerial thinking skills. By implementing PBL effectively, we can minimize the gap between theory and practice, as well as prepare students to become an adaptive and innovative workforce of the future [9]. PBL provides students with the opportunity to work collaboratively, design innovative solutions, and evaluate the results of their work, all of which are essential in vocational education.

Khoiri's research findings suggest that the implementation of PBL through traditional games significantly enhances students' creative and critical thinking skills across different proficiency levels (low, medium, and high) and also improves their collaboration abilities [9]. However, it was observed that the "improvised" criterion yielded the least improvement. The study underscores several positive outcomes of integrating Project-Based Learning via traditional games, highlighting ongoing developments in collaborative skills and critical and creative thinking strategies among students. Previous research, such as those conducted by Khoiri, has shown the benefits of PBL in improving students' critical and creative thinking skills, but the study focuses more on the use of traditional games as a learning method [9]. There have not been many studies that specifically examine the impact of PBL on the development of managerial skills in the context of vocational education and how creativity can

mediate these relationships. This research will fill this gap by assessing in detail how PBL affects students' managerial skills and how creativity plays a role as a mediating variable. Thus, this research contributes to the development of a more holistic learning model that can prepare vocational students more effectively to enter the increasingly competitive world of work.

In this study, the author will assess the impact of PBL on students' creativity and managerial skills in high school vocational education programs. The authors argue that PBL can significantly improve both of these skills, thus helping students become better prepared to enter the workforce with complete and relevant skills. Thus, this study aims to measure the extent to which the application of PBL can increase students' creativity in vocational programs in secondary schools. Creativity here includes the student's ability to generate new ideas, innovative solutions, and creative approaches to assigned tasks and projects and provide practical recommendations for his or her implementation in vocational education.

METHODS

This study uses an ex-post facto design to deeply analyze the influence of project-based learning on managerial skills, with creativity as a mediating variable [10]. There are three main variables that are the focus of this study, namely project-based learning as an independent variable, managerial skills as a dependent variable, and creativity as a mediating variable [11]. The research was conducted in several vocational high schools (SMK) located in the region of SMK YPI Darussalam 1 Cerme, focusing on students enrolled in the machining engineering programs. The population in this study includes students from the final year of their vocational programs, as they are expected to have developed some managerial skills and creativity through their academic and practical experiences. The sampling technique used was purposive sampling, which was used to select students who had participated in project-based learning activities during their vocational education. A total of 35 students were selected as respondents, ensuring that they had completed at least one major project as part of their curriculum.

Data collection was carried out through the Likert scale instrument, which has a range of 1-4, where this scale is designed to measure the level of disagreement to agree with various indicators submitted to respondents, as can be seen in Table 1 [12], [13]. To ensure the accuracy of the results, data processing and analysis were carried out using a simple linear regression technique on each variable [14][15][16]. This method allows researchers to clearly identify the relationship and influence that exists between project-based learning, creativity, and managerial skills. The results of this analysis are expected to provide a more comprehensive understanding of the dynamics between these variables and their contribution to the development of students' managerial skills.

Table 1. Likert score

No	Symbol	Definition	Scale
1	SS	Strongly Agree	4
2	S	Agree	3
3	TS	Disagree	2
4	STS	Strongly disagree	1

RESULT AND DISCUSSION

The relationship between project-based learning and students' managerial abilities is quite closely related. Because the project-based learning syntax shows the planning, implementation, and evaluation of the project that is set as the object of learning. This is part of the ability to manage things [17]. In addition, the effectiveness and comfort in the learning implementation process are also assumed to be influenced by students' creativity in carrying out managerial aspects of a project. So that the relationship of the three variables discussed is explained in Figure 1.

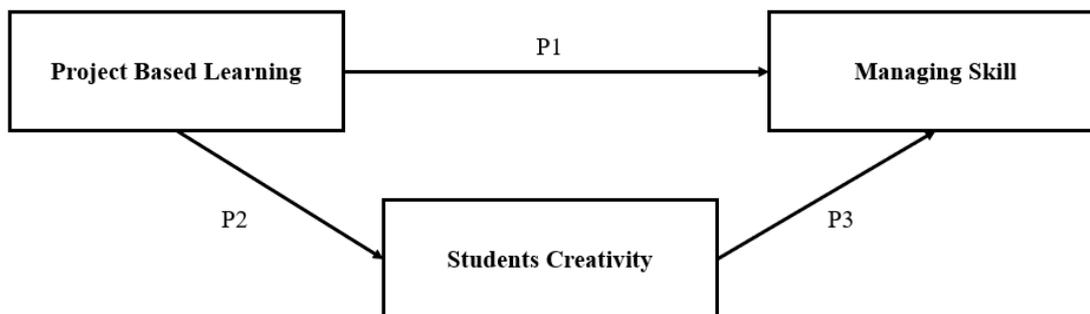


Figure 1. Relationship of Project Learning Variables, Managerial Skills, Creativity

The relationship between project learning and managerial ability (X and Y)

Project-based learning has been shown to significantly impact students' managerial abilities, particularly in areas such as task delegation, teamwork, and leadership. The statistical analysis yielded a significance value of 0.000, well below the threshold of 0.05, indicating a strong relationship between the two variables, as illustrated in Table 2.

Table 2. Coefficients of the Relationship Between Project-Based Learning and Managerial Skills

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1	Constant	10.048		20.907	0.006
	Project Based Learning	0.670	0.652	0.652	5.364

The results indicate that project-based learning explains 65% of the variability in students' managerial abilities, with a Standardized Coefficient Beta score of 0.65. Figure 2 illustrates the relationship between the variables, showing that although project-based learning contributes significantly to managerial skills, other factors such as family background and extracurricular involvement account for the remaining 35% of the variance. These figures show that project-based learning is beneficial not only in the context of academic learning but also in developing skills that are essential for students' professional and personal lives. Good management skills are essential for success in many aspects of life, including in the workplace, in organizations, and in everyday life.

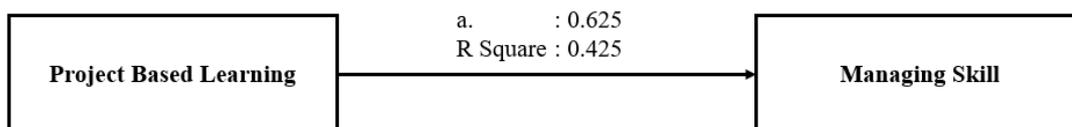


Figure 2. Influence of External Factors on Managerial Skills Development

However, it is important to note that although project-based learning makes a significant contribution, there is a 35% variability in student management abilities that is influenced by other factors outside of project-based learning. These factors can include family environment, previous work experience, involvement in extracurricular activities, and other social influences. According to research conducted by Fredricks et al., a supportive learning environment and active involvement in various non-academic activities have a great influence on the development of management and leadership skills in students [18]. In addition, studies by Long et al. show that social interaction and emotional support from family and peers have an important role in shaping management skills [19]. Further, Karunarathne and Calma emphasized the importance of student involvement in extracurricular activities that can enrich their learning experience and develop better management skills. Therefore, although project-based

learning is a very effective tool for developing management abilities, the development of these skills also requires a holistic approach that considers different aspects of students' lives [20]. This shows that the integration of various learning methods and experiences can be more effective in preparing students to face future challenges.

The relationship between project learning and student creativity (X and Z)

Project-based learning has great potential in encouraging students to develop critical thinking skills and creativity. Creativity, which is often defined as the ability to generate new and original ideas that have value, is one of the most in-demand competencies in the 21st century [21]. The implementation of PBP allows students to develop creativity through independent exploration, team collaboration, and the application of knowledge in relevant contexts [22]. Moreover, the relationship between project-based learning and creativity is equally significant, with a p-value of 0.000 and a Beta coefficient of 0.78, indicating that 78% of the variation in creativity is attributable to participation in project-based learning, as illustrated in Table 3.

Table 3. Coefficients of the Relationship Between Project-Based Learning and Creativity

Model	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	Constant	10.290		-0.228	.821
	Project Based Learning	0.995	0.128	0.780	7.780

These findings are further supported by Figure 3, which shows how creativity mediates the relationship between project-based learning and managerial skills. From the results of statistical analysis, it was found that the relationship between project-based learning and student creativity was very significant, with a p-value of 0.000, which was much smaller than the significance threshold of 0.05 (Sig. < 0.05). This shows that PBP has a strong and positive impact on student creativity. Furthermore, a Standardized Coefficients Beta score of 0.78 indicates that about 78% of the variation in students' creativity can be explained by participation in PBP. This figure confirms that project-based learning is not only an effective teaching method but also a key catalyst in the development of students' creativity, which can be applied in a variety of subject areas and learning contexts [23], [21].

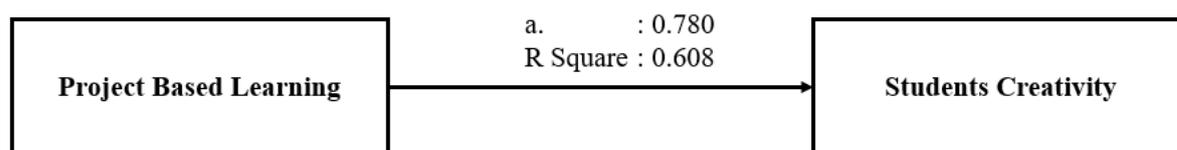


Figure 3. Mediation Effect of Creativity on Managerial Skills

These findings are further substantiated by various studies that emphasize the significant advantages of project-based learning in education. For instance, Hmelo-Silver (2004) demonstrated that project-based learning can enhance both critical and creative thinking, as it requires students to engage in deep and systematic thought processes [24]. Similarly, research conducted by Larmer and Mergendoller (2010) found that students involved in project-based learning exhibited substantial improvements in their capacity to innovate and solve complex problems [25]. The empirical evidence aligns with the current study, which found that project-based learning contributes to a 78% increase in student creativity. These results confirm that approximately 78% of the variability in student creativity can be attributed to participation in project-based learning. This reinforces the importance of integrating project-based learning into educational curricula, not only to develop academic knowledge but also to cultivate creativity and innovative thinking skills, which are crucial for addressing future challenges.

The relationship between project learning and students' managerial abilities is mediated by the level of student creativity

As shown in Table 4, project-based learning has been known as an active and engaged learning approach, which puts students in situations that allow them to learn through projects that require problem-solving, collaboration, and creativity. Theory and research show that project-based learning not only improves conceptual understanding but also facilitates the development of social skills, critical thinking, and creativity [26]. Creativity, as the ability to generate new and original ideas that have value, is a key factor in a learning context that emphasizes exploration and innovation. Lastly, the mediation analysis showed that project-based learning directly influences managerial skills, with a Beta score of 0.45 when creativity is included as a mediating variable. However, creativity itself was found to be a non-significant moderator, with a significance value of 0.136.

Table 4. Calculation of the relationship between variables X, Y, and Z

Model	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	Constant	9.889		3.009	.005
	Project Based Learning	0.437	0.196	0.452	2.227
	Creativity	0.234	0.154	0.290	1.522

Based on the statistical analysis, PBL was found to have a significant effect on managerial skills, with a significance value of 0.032, which is below the 0.05 threshold ($p < 0.05$). However, when creativity was introduced as a moderating variable, its effect was not significant, with a p-value of 0.136. These findings suggest that although creativity plays a role in the PBL context, it does not significantly moderate the relationship between PBL and managerial skills.

The analysis also shows that PBL contributes 45% to the development of students' managerial skills when creativity is considered as a moderator, as illustrated in Figure 4. Without creativity as a moderating factor, the direct effect of PBL is around 29%. Thus, while creativity enhances the impact of PBL to some extent, it does not play a significant moderating role in this relationship. Nonetheless, PBL remains an effective method for developing both managerial skills and creativity in students.

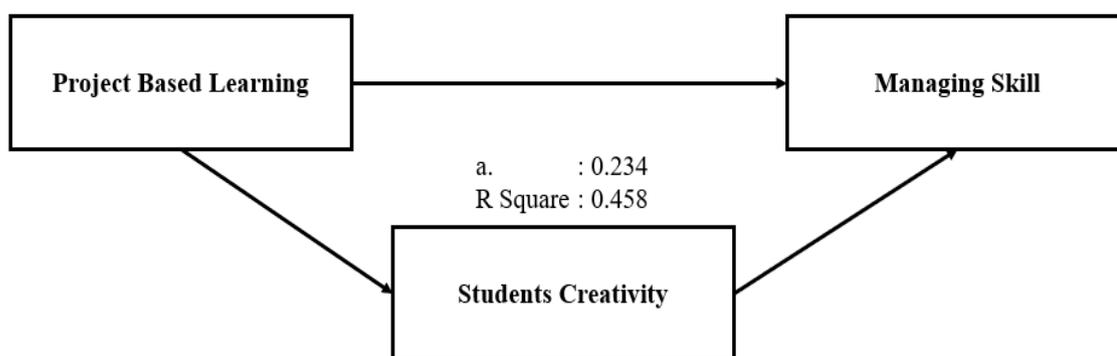


Figure 4. Variable relationship schema

These findings are consistent with previous research highlighting that project-based learning not only improves academic skills but also develops social and professional skills, including managerial abilities[27]. A study by Bellanca & Brandt (2010) emphasizes that PBP can be an important bridge in connecting creativity with practical skills needed in the modern world of work. Thus, although creativity does not act as a significant moderator in the relationship between PBP and managerial skills, PBP remains relevant in preparing students for future challenges by developing complex and critical skills [28].

CONCLUSION

From the results of the analysis carried out, it can be concluded that PBL has a significant impact on the development of students' managerial skills in the field of CNC machining engineering. A significance value of 0.032 indicates a strong relationship between PBL and managerial skills. However, creativity as a moderation variable did not show a significant influence, with a significance value of 0.136, which showed that creativity did not moderate the relationship between PBL and managerial skills significantly. Nevertheless, PBL still had a major influence on improving students' managerial skills, with an influence of 45% when creativity was considered as a moderation variable. In contrast, the direct influence of PBL without involving creativity was about 29%. These results confirm that PBL is effective in developing the managerial skills needed in the CNC machining engineering industry, although creativity does not affect this relationship significantly.

PBL also plays an important role in promoting student creativity in the context of CNC machining engineering education, which involves the integration of aspects of informatics, electronics, and mechatronics. The study shows that although creativity does not serve as a significant moderator, PBL remains relevant and beneficial in preparing students to face future industry challenges with comprehensive skills.

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