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The Effect of Project-Based Learning Implementation on the Mastery of 4C Skills of SMK Students

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ABSTRACT: This study aims to determine and analyse: (1). the implementation of Project-based learning (PjBL) in productive subjects in vocational schools, (2) the effect of the implementation of Project-based learning (PjBL) on the mastery of the 4Cs of vocational students This study uses quantitative research methods through a quasi-experimental design approach with a total population of 131 students, namely in class XI Automotive Engineering SMKN 2 Negara in the 2024/2025 academic year. Determination of the sample in this study using purposive sampling, namely class XI TSM 1 as an experimental class with a Project-based Learning model totalling 35 students and class XI TSM 2 as a control class with a conventional learning model totalling 36 students. The research instruments used include pre-test and post-test, student and teacher questionnaires, observation, interviews and documentation. Based on the research results obtained: (1) the implementation of the PjBL learning model is well implemented as indicated by the results of the evaluation of the lesson plan (100%), observation of the implementation of PjBL (96%), increasing student participation (98%). (2) The implementation of the Project-based learning model (PjBL) has a significant effect on the mastery of students' 4C skills (Critical Thinking, Creativity, Communication and Collaboration) by 71.7%. Regression analysis shows the contribution of PjBL to critical thinking skills (12.1%), creativity (14.3%), communication (16.7%), and collaboration (12.6%), as well as the difference in improving learning outcomes in the experimental class by 53% compared to the control class by 39%.

KEYWORDS: Project-based Learning, 4C (Critical Thinking and Problem Solving, Creativity and Innovation, Communication, and Collaboration)

I. INTRODUCTION

The development of the world in the 21st century is characterised by rapid changes in various fields, especially in terms of technology, communication, and information (Putri et al., 2022). These changes have a significant impact on various aspects of life, including in the world of education. The education system is expected to be able to produce graduates who have skills in accordance with the demands of the times, not only in terms of technical knowledge but also fundamental abilities needed to compete in the global era (Arifin & Mu'id, 2024). According to a World Economic Forum report in 2023, 44% of future jobs do not exist today, which shows the importance of preparing young people with adaptive and flexible skills (Dunia, 2024).

The massive digital transformation is fundamentally changing the face of the world of work. Automation and artificial intelligence have taken over many routine jobs, while the demand for labour with higher-order thinking, creativity and interpersonal skills is increasing (Sudibyo, 2022). In this context, vocational education has a very important role in preparing a workforce that is ready to face these challenges (Sumarsono, 2021). Vocational High Schools (SMK) as educational institutions that prepare students to enter the world of work face greater challenges in meeting the demands of the 21st century (Sari, 2023).

SMK graduates are not only required to master specific vocational competencies, but must also have broader skills known as 21st century skills or 4C (Critical Thinking and Problem Solving, Creativity and Innovation, Communication, and Collaboration) (Handayani, 2024). Data from the Ministry of Education, Culture, Research and Technology in 2023 shows that only 45% of SMK graduates work in accordance with their field of expertise, while 30% work in different fields, and the rest are still looking for work or continuing education (Hubbaya, 2023). The open unemployment rate (TPT) of SMK graduates in 2023 reached 9.31%, higher than other levels of education, indicating a gap between the competencies of graduates and the needs of the labour market (Statistics, 2024).

Further analysis revealed that 65% of employers rated SMK graduates as lacking adequate critical thinking and problem-solving skills (Prakoso, 2023). Preliminary research in Bali showed that the implementation of a 4C-oriented learning model (PBL) in Balinese language learning was able to significantly improve student learning outcomes. This suggests that innovative learning approaches can contribute to the development of skills relevant to industry needs (Damayanti et al., 2024).

One alternative to overcome this problem is the project-based learning (PjBL) model, which is student-centred and uses projects as learning tools (Susmidah, 2021). Through PjBL, students can actively construct their own knowledge through real experiences in completing complex and meaningful projects. Recent research shows that the implementation of PjBL can significantly improve students' critical thinking skills, which is one of the important aspects in 21st century skills (Ghina, 2023).

By looking at the urgency and challenges that exist, this study aims to explore the effect of PjBL implementation on students' mastery of 4C skills at SMK Negeri 2 Negara, so that graduates can be better prepared to face challenges in the changing world of work. This research is expected to make a significant contribution in the development of more effective learning methods in SMK.

In the context of modern education, the Project-Based Learning (PjBL) learning model is becoming one of the increasingly popular methods. PjBL focuses on the active engagement of students through meaningful projects, which allows them to learn in a more contextualised and applicable way (Cynthia & Sihotang, 2023). According to the Buck Institute for Education (BIE), PjBL involves investigations structured around complex and authentic questions, which not only enrich students' knowledge but also hone 21st century skills (Auvisena et al., 2024).

One important aspect of PjBL is the notion that students not only learn about academic content, but also develop collaboration, communication, and problem-solving skills (Firmansyah, 2020). For example, in a study conducted by Akbar et al. (2023), it was found that students who engaged in PjBL showed significant improvements in critical and creative thinking skills compared to traditional learning methods.

PjBL has characteristics that distinguish it from conventional learning methods. One of the main characteristics is the presence of complex questions that are the focus of the project. These questions are designed to encourage students to conduct in-depth investigations (Bala, 2021). In addition, students are given autonomy to determine the direction of their project, which increases their sense of responsibility and involvement in the learning process (Nihayah, 2023).

In its implementation, PjBL also emphasises the importance of project relevance to the real world. This not only makes learning more interesting but also helps students understand the practical application of the concepts they are learning (Noviati, 2021). For example, students who engage in projects related to environmental issues can develop a better understanding of the environmental impact of human activities.

Implementing PjBL requires careful planning and structured steps. The first step is to determine the essential question that will be at the centre of the project. This question should be relevant to students' real lives and encourage them to think critically (Lucky, 2024). Next, students, with teacher guidance, plan the steps that will be taken to answer the question, including task assignment and scheduling.

Monitoring project progress is also an important part of PjBL. Teachers should actively monitor students' progress and provide constructive feedback (Mergendoller & Larmer, 2015). In addition, regular reflection by students and teachers on the learning process is essential to improve the effectiveness of the project (Widayanthi et al., 2024a). In this context, the end-of-project evaluation is also an important moment to assess students' work and provide feedback on the skills they have developed.

PjBL has a number of advantages, including the development of 21st century skills, increased student motivation and engagement, and a deeper understanding of the material (Noviati, 2021). However, PjBL also has disadvantages, such as the need for more time and resources, and challenges in assessment (Akbar et al., 2023). Therefore, it is important for educators to consider both these advantages and disadvantages when designing and implementing PjBL in the classroom. The 4C skills are essential in 21st century education and are the main focus in the implementation of PjBL. These skills include critical thinking and problem solving, creativity and innovation, effective communication, and team collaboration (Pare & Sihotang, 2023). The emphasis on developing these skills helps students to not only be ready to
face challenges in the world of work, but also to contribute effectively in society.

II. METHOD

This research is a quantitative study with a quasi experimental design approach. According to Adiputra et al. (2021), quasi experiment is a study that places experimental units into experimental groups and control groups without randomisation (non-random assignment). This approach was chosen because the research objective was to examine the effect of the project-based learning (PjBL) learning model on students' mastery of the 4Cs. Given that the research subjects are in classes that have already been formed, sampling cannot be done completely randomly (Supriatna et al., 2023). The research design used was a nonequivalent control group design, in which there were two groups selected non-randomly. Before treatment, both groups were given a pretest, then different treatments were carried out, and ended with a posttest. The experimental group will get learning with the PjBL model, while the control group will get conventional learning (Abraham & Supriyati, 2022).

This research was conducted at SMK Negeri 2 Negara, Negara District, Jembrana Regency, Bali Province. The selection of this location was based on the consideration that SMK Negeri 2 Negara is one of the leading schools that has implemented the Merdeka Curriculum and some teachers have implemented project-based learning. This research was conducted in the even semester of the 2024/2025 academic year, precisely from December 2024 to May 2025.

The population that is the focus of this study are all students in class XI of SMK Negeri 2 Negara in the 2024/2025

academic year. These students are spread across various expertise programmes. Details of the population can be seen in the distribution table of class XI of SMK Negeri 2 Negara, which shows the number of students in each expertise concentration. The population was focused on students of the Automotive Engineering Expertise Programme, which numbered 131 students, because it has a close relevance to the research topic. The selection of this population is considered very suitable to support the research objectives to be achieved.

The sample in this study was taken using purposive sampling technique. Considerations in the selection of samples include equality of student characteristics and initial abilities, similarity of expertise programmes to avoid bias, and teaching by the same teacher. The samples used consisted of Class XI TSM 1 as the experimental class and Class XI TSM 2 as the control class. Sample details can be seen in the research sample distribution table, which shows the number of students in each class.

The independent variable in this study is the project-based learning (PjBL) learning model, while the dependent variable is students' mastery of 4C which includes critical thinking, creativity, communication, and collaboration. Each dependent variable has clear indicators to measure students' ability in these aspects. Measurements were made through observations, interviews, and questionnaires, which were designed to obtain valid and reliable data regarding the application of the PjBL learning model and students' mastery of the 4Cs.

III. RESULT AND DISCUSSION

A Description of Respondents

This research involved Motorcycle Engineering productive subject teachers and grade XI students at SMK Teachers who became respondents were the teachers of Motorcycle Electrical Maintenance and Repair subjects. They have an important role in designing and implementing the learning process in accordance with the Project Based Learning (PjBL) learning model. Student respondents consisted of two classes, namely class XI TSM 1 (experimental class) and class XI TSM 2 (control class). The experimental class applied PjBL, which requires students to be active in designing and completing real projects. In contrast, the control class used a conventional learning model that was more teacher-centred. Data shows that the implementation of PjBL is expected to increase students' active engagement as well as critical thinking and collaboration skills (Mergendoller & Larmer, 2015).

B. Project Based Learning Lesson Planning

Evaluation of the Learning Implementation Plan (RPP) showed that the aspects of module identity and teaching materials scored 100%. This indicates that the lesson plan has been well prepared and fulfils all the necessary criteria. This is important because good lesson plans guide the learning process aimed at developing 21st century skills. Thus, well-designed lesson plans can improve the quality of learning and facilitate the achievement of student competencies (Lucky, 2024).

C. Implementation of Project-based Learning

Observation of the implementation of PjBL shows that respondents successfully implemented the learning with a 96% achievement percentage. Although there are some aspects that need to be improved, such as determining essential questions which only reached 80%, overall the implementation of PjBL is very good. The results of interviews with teachers also show that they have implemented strategies that encourage active student participation. However, the relevance of the project to the industrial world still needs to be strengthened so that students can develop skills that are relevant to the needs of the labour market (Amroni et al., 2024).

D. PjBL Implementation Questionnaire

The questionnaire results show that PjBL implementation has been carried out well, with a total score of 98%. However, some aspects such as evaluation and experience as well as determining essential questions show lower scores. This indicates that in-depth reflection and the formulation of critical questions still need to be improved to support the development of students' critical thinking skills (Firda & Sunarti, 2022).

E. Assessment of Student Learning Outcomes in the Implementation of PjBL

Pretest and posttest data show a significant increase in the learning outcomes of students in the experimental class compared to the control class. The experimental class showed an increase in the average score from 49.94 to 76.40, while the control class only increased from 48.69 to 68.61. This improvement indicates that PjBL is effective in enhancing students' understanding and 21st-century skills (Sutejo et al., 2021).

IV. CONCLUSION

Based on the research data and discussion, the following conclusions can be drawn:

A. The implementation of the Project-based Learning (PjBL) model in productive subjects at SMK Negeri 2 Negara showed very satisfactory results. From the evaluation of the Lesson Plan (RPP), 100% compliance was recorded, indicating thorough and comprehensive planning. Observations of PjBL implementation recorded a high score of 96%, reflecting the active involvement of teachers in the learning process. This aligns with research by Thomas (2000), who stated that teacher involvement in PjBL contributes to student success. In addition, the increase in student participation, which reached 98%, indicates that this method

successfully attracted students' interest to be directly involved in learning. Thus, PjBL not only improves academic outcomes but also develops students' social and collaborative skills, making it an effective and relevant learning model in today's educational era (Bell, 2010).

B. The implementation of the PjBL learning model at SMK Negeri 2 Negara has been proven to have a significant impact on students' mastery of the 4C skills (Critical Thinking, Creativity, Communication, and Collaboration) by 71.7%. PjBL not only improves learning outcomes but also develops critical thinking, creativity, communication, and collaboration skills. Students involved in the project showed an increase in critical thinking of 12.1%, while their creativity increased by 14.3%. Communication and collaboration skills also improved by 16.7% and 12.6%, respectively. Analysis of pretest and posttest results showed that the experimental class experienced a significant increase with an N-Gain of 53%, compared to the control class, which only increased by 39%. These findings indicate that PjBL is effective in equipping students with the 21st-century skills that are so badly needed, in line with research conducted by Saavedra and Opfer (2012) emphasizing the importance of these skills for students' future readiness.

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