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Jurnal Teknologi Pendidikan

Developing a project-based learning module to improve vocational students' absorption and skills

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A B S T R A C T	**A R T I C L E I N F O**
The creation of learning modules based on project-based learning (PBL) is designed to enhance students' understanding of the material and their work skills in vocational high schools (SMK). This research intends to illustrate the effectiveness of the PBL module in enhancing students' comprehension of the material and their practical abilities. The creation of this module is founded on the model of Dick and Carey (Analysis, Design, Development, Evaluation). Field trials were carried out on 40 students specializing in TKJ and studying computer networks to evaluate their learning achievement in terms of material absorption (knowledge), as well as their skills and attitudes during the learning process. The outcomes of creating a project-based learning module for the computer network practicum, according to the evaluation by material experts, stand at 96.7%, indicating that it is suitable for testing. Subsequently, the test results indicate that this project-based learning module can reach a material absorption (knowledge) outcome of 78%, classified as high, alongside skills and attitudes demonstrating an effectiveness of 83.2%. Hence, it is advisable that the PBL module be more broadly incorporated into the SMK curriculum to equip students for the growing competitiveness of the job market. Nevertheless, the effective execution of this module greatly relies on the accessibility of sufficient resources and the readiness of teachers to handle project-based learning.	

1. INTRODUCTION

The development of current work needs requires graduates to have Future Skills in order to survive in the work environment. Future skills refer to the ability to act successfully on a complex problem in the context of unknown future actions (Ehlers, U. D., & Kellermann, S. A., 2019). These future skills are very important for graduates to have in the era of disruption (Erfiati E, Lailatussaadah L, 2022). In 2020, the World Economic Forum (WEF) published the top 15 cross-functional skills based on global industry demand for 2025 (World Economic Forum, 2020). The Organisation for Economic Co-operation and Development (OECD) published the OECD Learning Compass 2030, which defines the knowledge, skills, attitudes and values that learners need to fulfil their potential and contribute to the well-being of their communities and the planet (OECD, 2024).

Learning development is an urgency that needs to be done to train students' future skills (Ehlers, 2019; Muhali, 2019). Learning innovation is needed in learning activities to achieve learner competence (Rahayu et al, 2022). The development of education which is currently a must for every educational institution to implement Merdeka Belajar, abbreviated as MB, so that there is freedom in learning by students and teachers as educators. The implementation of MB also takes place in SMK by implementing the MB curriculum in each school, while the implementation of learning teachers can freely use learning models in the hope that learning outcomes will be achieved.

Efforts are being made to improve the quality of learning, one of which is the use of learning media as a tool in the teaching and learning process. Learning media is a tool that allows students to understand and remember something easily for a long time compared to the delivery of subject matter by face-to-face and lecture without tools (*Thompson*, John F., *1973*). Learning media has different types that need to be adapted to the needs of the teacher or the teacher to his students in designing learning (Rusman, 2017). Likewise, the efforts that have been made in SMK Ma'arif NU Batang Regency, based on the results of observations that have been made that the skills taught have not met industry standards, one of which is in the subject of Computer Networks (JARKOM) Computer and Network Engineering Department (TKJ). The implementation of the independent curriculum policy of SMK Ma'arif NU Batang Regency uses a project-based learning model (PJBL) in it's practical learning. Project-based learning is a learning model that places the project at the centre of learning (Hamid MA, dkk, 2020). The problems that occur in schools are (1) lack of media to support PJBL learning; (2) lack of creative thinking attitude of students, so it affects the absorption of student material and student skills. So, it can be concluded that the problems that occur in the classroom, especially in learning computer network practicum, are the lack of integration of knowledge, skills, attitudes and values, as well as the gap between hard skills and soft skills of students contained in the learning modules used, so that learning is less effective both in the absorption of material and skills.

Therefore, the urgency of this research is to direct the learning context in SMK to create opportunities to incorporate innovative learning methods, one of which is the project-based learning (PJBL) model, which has not been running optimally in the school by making the development of project-based learning modules, it is expected that there will be a paradigm shift in learning from the centre to the students, allowing students to engage in real projects that reflect workplace situations. In addition, project-based learning not only improves technical skills, but also promotes character development such as creativity, initiative and cooperation. This is in line with the trend of character education. Thus, the development of a project-based learning module is expected to

provide a solution to improve the material absorption and work skills of vocational students.

The focus of problem solving in this research is an effort to integrate knowledge, skills, attitudes and values to train students' future skills during computer networking practical activities, one of which is the Virtual LAN (Configuration and Security) learning module running effectively. For this reason, it is necessary to innovate in learning by implementing the Project Base Learning (PjBL) model, which is a project-based learning approach, as many studies prove that this method is effective in improving students' understanding and practical skills and ways of thinking from the experience gained while carrying out learning (Syofiani, 2023; Sari, 2024). Various studies also show that learning with PPA can improve future skills such as critical thinking, creative thinking, problem solving, socialising, communicating and collaborating .Its application to practical learning in the laboratory is expected to be one of the methods aligned with the MBKM programme that can provide opportunities to improve various student skills (Sherly, S., 2021; Azhar Arsyad, 2013; Yamin, 2020,).

Therefore, **the formulation of the problem in this study** is the effectiveness of using learning modules by implementing the Project Base Learning Model (PjBL) to improve the absorption of material and work skills of vocational students? From the formulation of the problem, **this study aims to develop a learning module that implements the PJBL model to support practical learning and improve the absorption of material and work skills of vocational students**, so that it can provide contextual learning experiences, promote creative critical thinking skills in case and project-based problem solving, and strengthen the application of concepts to real-world situations, as well as provide recommendations for further improvement and development.

2. METHODS

In relation to the research objectives, namely to develop a Project Base Learning Model (PjBL) in SMK, this research uses developmental research (R&D) with the Dick and Carey model approach (Dick, W. & Cary, L. 1990).

A.   Analysis of data

At this stage, field analysis and teaching analysis are carried out. The field analysis is based on the learning needs of the students while participating in the practical activities in the laboratory. Instructional analysis aims to determine the target achievements in practical learning in computer networking subjects, especially virtual LAN material, which includes knowledge, skills and attitudes/character.

B.   Design level

The design stage is carried out by applying the PJBL model in the preparation and production of learning modules. This is combined with collaborative project-based learning to support the achievement of student competencies in practical learning.

C.   Development phase

This stage is carried out through the implementation of practical learning about computer networks, especially virtual LAN material with the PJBL model. The result of this development is a learning module that is a project-based learning and collaborative learning approach. This includes the use of learning strategies that encourage students to actively participate in practical projects, collaborate with fellow students, and solve problems independently or as a team to maximise the absorption of material and student skills.

D.   Examination Stage

Expert testing is needed to determine the validity and feasibility of the developed learning module (Dangkua, 2023). The material testing instrument in the developed computer network learning module includes testing aspects of learning outcomes, content suitability and material presentation with a total of 18 items. Instrument validation was conducted on 1 expert in the field of learning evaluation to determine the feasibility of the question items.

Material expert testing was carried out on 2 experts in the field of educational and computer network learning materials. Data were collected using a questionnaire with 4 Likert scales. The percentage results were converted into 5 eligibility criteria (Harsiwi, 2020).

The field test phase included all students majoring in TKJ, with a total of 40 respondents divided into 2 classes. The respondents were tested using a pre-test, post-test, and observation of practical performance assessment sheet. The indicators of competence achievement measured include aspects of: communication, collaboration, critical thinking and problem solving, creativity and innovation. The results of the pre-test and post-test scores were calculated using the N Gain (Normalised Gain) formula as follows (Sukarelawan, 2024).

The N Gain values obtained were then converted based on the N Gain score criteria (Table 1). To determine the level of efficacy, see Table 2.

Tabel 1. Kriteria Skor N Gain

Nilai N Gain	Kategori
$0,70 \leq g \leq 1,00$	Tinggi
$0,30 \leq g < 0,70$	Sedang
$0,00 < g < 0,30$	Rendah
$g = 0,00$	Tidak Terjadi Peningkatan
$-1,00 \leq g < 0,00$	Terjadi Penurunan

Tabel 2. Kriteria Penentuan Tingkat Keefektifan

Persentase (%)	Kategori
< 40	Tidak Efektif
40 – 55	Kurang Efektif
56 – 75	Cukup Efektif
> 76	Efektif

3. RESULTS AND DISCUSSION

This research results in an evaluation of the effectiveness of learning through the development of a learning module for the Project Base Learning (PBL) learning model, specifically Virtual LAN (Security Design & Configuration) material. It is designed to provide students with learning experiences by using the senses of sight, hearing and movement. The learning method used is a project where students are given the opportunity to explore the learning material through computer network practical projects. The following are the results of the development of learning modules based on the stages of research carried out:

A.   Analysis of data

The results of the analysis of the field case study based on the observations made are The results of the analysis show that vocational students have a variety of learning styles. Observations revealed that students with kinaesthetic learning styles have difficulty understanding concepts without hands-on practice, while auditory students need verbal explanations to support visual material. Therefore, there is a need for a learning module

that can accommodate these different learning styles by combining visual, auditory and kinesthetic elements in one medium. This module is designed to support project-based practical learning in SMK, which aims not only to increase students' absorption of theory, but also to train work skills relevant to the industrial world.

The teaching analysis uses the Project-Based Learning (PJBL) model as the main approach, given its effectiveness in improving analytical and problem-solving skills. The module guides students through the steps of PJBL, such as identifying the fundamental question, designing the project, planning the work, monitoring progress, evaluating results and reflecting on learning. Through this approach, students are expected to be able to put theory into practice through real projects, while developing technical skills and soft skills such as collaboration, communication and time management.

B.   Design level

The Project-Based Learning (PJBL) model was chosen for the learning module because it is considered effective in improving students' work and analytical skills. PJBL also encourages students to actively participate in learning, solve problems and develop critical thinking skills.

Learning activities are designed based on the syntax compiled in the activities of the practical module (Figure 3). Learning through this project can improve critical thinking, creativity, problem solving, communication and collaboration skills (Nuryana, 2022; Rosidin, 2022; Siswati, 2023). The framework of this practicum module is prepared to be used as an independent learning resource for students.

Figure 3. Practical Module Framework

Based on the practicum module framework, the design developed is in points E, F, G, and H which contain the steps of PJBL (Figure 4).
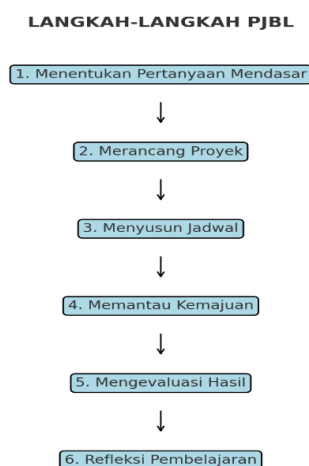
Figure 4. Development of PjBL Learning Module

Each stage of the practical activity module is written in easy-to-understand language and is also packaged with learning aids in the form of learning videos that can trigger sensory activities (seeing, hearing and moving), so that it can be used to meet the needs of students' learning styles.

C.   Development phase

At this stage, students begin to try out the learning that has been packaged in the design stage with the learning module that has been developed based on PJBL. Students follow the syntax that has been created, which focuses on providing students with real projects that allow them to apply the knowledge and skills they have learned (attached). In addition, student learning is also supported by the existence of relevant learning videos for computer networking topics, especially for Virtual LAN material (computer configuration and security). The length of each video developed ranges from 3 to 5 minutes. Considerations in determining the duration of learning videos are based on the activity of the sensory organs (vision, hearing, and movement), which can work optimally with a duration of less than 7 minutes (Yuniastuti, 2021)). The following is one of the learning processes carried out by students (Figure 5)

Figure 5. PjBL Learning Module Development Computer Networking Internship

D.   Examination Stage

The results of the development of learning modules with the Project-Based Learning (PJBL) model were tested by material experts because they focused on the material provided based on PJBL. The review by material experts is based on aspects of learning outcomes, content suitability and material presentation (Table 1).

Table 1. Results of expert material tests

No.	Aspect	Indicator	Percentage of total
1	Learning outcomes	Adequacy of learning outcomes	16,1%
2	Content appropriateness	Appropriateness of content	27,8%
3	Presentation of material	Appropriateness of PJBL syntax (project)	31,7%
		PJBL Model	21,1%
Rata-rata			**96,7%**

Based on the results of the expert tests, the average percentage of material experts was 96.7%. It can therefore be concluded that the developed learning media are suitable for use in learning. The suggestions for improvement from the material experts are to make

observations and analyses and to provide projects that are in accordance with the learning style of the students, so that the students in some practical sessions understand explanations according to their learning style and each project completion is given a real learning video.

A field trial was conducted with 40 students in the Department of Computer and Network Engineering (TKJ). The aim of the trial is to determine the learning outcomes of computer networking using the developed practical learning media. Learning outcomes are measured based on knowledge, skills and attitudes. Knowledge achievement is determined based on pre- and post-test scores (Table 2). While the achievement of skills and attitudes is obtained based on the results of the Practical Performance Observation Assessment Sheet (Table 3).

Table 2. Pre-test and post-test scores

No	Respondents	Average pre-test score	Average post-test score	N-Gain	Category
1	21	64	91,3	0,76	**High**
2	19	46,2	90,2	0,82	**High**
Total	40	55,1	90,75	**0,79**	**High**

Table 3. Results of the Practical Performance Observation Rating Sheet

No	Respondents	Future Skills				Achievement percentage
		Communication	*Collaboration*	*Critical Thinking and Problem Solving*	*Creativity and Innovation*	
1	19	86,7%	80%	93,3%	60%	80%
2	21	95,8%	91,7%	79,2%	60%	79,2%
Total	40	91,25%	85,85%	86,25%	60%	**79,6%**

The results of the pre- and post-test assessment of student learning showed a significant difference in value. The average N gain value of all respondents was 0.79 with a high category. This shows that the use of learning modules based on the Project-Based Learning (PJBL) model can meet the achievement of knowledge in this case is to increase the absorption of material.

The results of the practical performance observation assessment, seen from the indicators of competence achievement: communication, cooperation, critical thinking and problem solving, creativity and innovation, showed that the achievement of competence in the communication aspect was 91.25%, in the cooperation aspect was 85.85%, and in the critical thinking and problem solving aspect was 86.25%. In the aspect of creativity and innovation, some students did not achieve the competence with a score of 60%. The overall percentage of students achieving the competence was 79.6%. Thus, it can be concluded that most of the students have achieved good skills and attitudes in the learning process carried out.

4. CONCLUSION

The results of the development of practical learning modules with the implementation of the project-based learning (PJBL) model can be used as innovative teaching materials. The use of this PJBL-based learning module can fulfil the research objectives of increasing students' material absorption (knowledge) and improving students' work skills (skills and attitudes). Further research is needed on the influence of learning styles on skill attainment, especially in the aspects of creativity and innovation for the attainment of students' future skills, because based on a deeper evaluation of the test results, the lack of competence in the aspects of creativity and innovation is dominated by students with visual and auditory learning styles, while students with kinesthetic learning styles can fulfil the learning outcomes.

5. AUTHORS' NOTE

Well, the authors declare that they have no conflicts of interest with regard to the publication of this article and that the article is free of plagiarism.

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