Project-Based Learning Concept Map in Vocational Education

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Project Based Learning Concept Map in Vocational Education

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Abstract

Introduction to The Problem: Along with the times, the learning process in schools, especially in vocational education, needs to be improved. Likewise, teacher competencies and skills are expected by the industry, so the learning process emphasizes improving work competencies.
Purpose: This study aims to explore learning in project-based vocational education to produce a concept map that can be used for competency development for vocational teachers.
Design/methods/approach: This research is a literature review with a systematic literature review approach. The data used are the results of publications that are relevant to the research theme. The results of the publications used were found in various journal databases.
Findings: The PjBL approach is used as a learning method that can help the process of critical and creative thinking, raising problem issues in the community. Students play a role in solving problems in their scientific fields. Based on the findings of the research results/concept map produced, this study has a novelty consisting of five components in the PjBL learning model in SMK, namely the learning model component, learning step, skills, supporting factors, and competency achievement.
Research implications/limitations: The results of this study have a direct impact on vocational education units, especially school principals and productive teachers to be able to develop learning competencies through the right approach in accordance with student needs and the relevance of competencies expected by the industry. In the end, the learning process carried out can be used as capital and basis for students and graduates for employment and absorption of graduates.
Originality/value: This research is a literature study so it needs to be redeveloped through various research approaches so that the expected results can be implemented in vocational education units.

Keywords : Concept map; project-based learning; vocational education

Introduction

Curriculum development at each level of education experiences changes along with the development of Science and Technology (IPTEK). Changes in the education curriculum are adjusted to current developments. The previous education curriculum was the 2013 Curriculum (K13) which was implemented precisely in July 2013 (Karoror, Widyaningsih, Sebayang, & Yusuf, 2020). The aim of the 2013 curriculum is to prepare individuals who are faithful, productive, creative, innovative and affective (Sasmita & Hartoyo, 2020). To improve the quality of human resources, the Minister of Education and Culture implemented the "Freedom to Learn" education program which is used as a direction for future learning.

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The legal basis that accompanies efforts to improve the quality of human resources is based on the Preamble to the 1945 Constitution, paragraph IV, in order to make the nation's life more intelligent; Article 31 paragraph 3 states that the government seeks and organizes a national education system in order to educate life (Sherly, Dharma, & Sihombing, 2021).

In the Independent Curriculum, students' competencies are developed optimally, namely by increasing extracurricular time at school. The independent curriculum really appreciates learning models that can explore students' potential and creativity, and can touch all aspects, including knowledge aspects, attitude aspects and skills aspects (Nainggolan, Pontororing, & Tinus, 2021); (Bilqisthi et al., 2023). Learning is carried out using various methods, according to material and learning needs. Educators are given the authority to use learning tools in the learning process (Anas, Ibad, Anam, & Hariwahyuni, 2023). Based on the observations of Wicaksana dan Sanjaya (2022) problems were identified, including students having difficulty analyzing a problem. Students experience difficulty in explaining problem phenomena and are unable to develop a scientific attitude in relating the knowledge gained in lectures (Wicaksana & Sanjaya, 2022). saw that students still had difficulty solving problems. The cause of low problem-solving abilities can come from students or teachers (Nopiyanto & Mahmudah, 2023). The majority of schools still tend to apply a monotonous learning model, so that students are only able to absorb the material without the ability to implement the material they have learned in class. Furthermore, this condition also has an impact on students' low level of creativity (Ilahiyyah, Iriani, Harti, & Fauzuddin, 2021).

Several studies have been conducted on the topic that the application of the project based learning (PjBL) model in the era of independent learning has no effect on improving students' scientific attitudes. Bagheri, Ali, Abdullah and Daud (2013) said that PjBL learning opens up opportunities to convey ideas, listen to other people's ideas, and reflect their own ideas on others. Wicaksana and Sanjaya (2022) found that the implementation of innovative learning models such as PjBL has not been optimal. Students have difficulty adapting to this learning model. Participants' enthusiasm for learning is not yet used to being implemented independently. The PjBL model approach has advantages, including fostering student independence, increasing attitudes of responsibility for themselves, developing skills in solving problems, and expanding access to learning (Lutfi & Asmawati Azis, 2018). However, Hadi, Suprianto and Santosa (2019) found that there were symptoms of ineffectiveness, inefficiency and lack of relevance in the implementation of PjBL learning. Therefore, the STEM approach is the most appropriate alternative learning method for developing students' problem solving skills. Product engineering in STEM learning has a strong relationship with project creation in PjBL learning approach.

According to the results of the 2018 PISA (Program for International Student Assessment) survey for scientific skills, Indonesia was ranked 70th with a score of 396 out of the overall average score, 489, from 78 countries. This sho that Indonesia still has low scientific skills (Ridlo, 2020). Therefore, more innovative and stimulating learning models are needed to improve scientific skills. The PjBL-STEM approach is used as a learning method that can help students' critical and creative thinking processes, raise problematic issues in the community by solving problems according to their scientific field. Based on the background of the problem above, the aim of writing this article is to explore the conceptualization of the PjBL learning model at the vocational school level.

Methods

The design used in writing this article is a *systematic literature review*. Data retrieval techniques using *literature search* are through *the Google Scholar* journal database. The keywords used to search for journals are *"project based learning"*, "STEM" and "PjBL-STEM". From the keyword *"project based learning"* there are 5 articles, "STEM" there are 5 articles and "PjBL-STEM" there are 5 articles. The collected articles were then screened according to relevant studies, thus obtaining as many as 15 articles used for theoretical construction of the conceptual model of PjBL-STEM learning in SMK. Article search is limited to the last 5 years 2019 to 2023. The reason for searching for the last 5 years is to focus on the results of PjBL-STEM learning publications in vocational schools today. It also aims to make the results of *systematic literature review* a fundamental part for educational institutions to develop it.

Data analysis techniques using qualitative, the sequence is to make reductions, create codes, and compile concept maps. Data analysis techniques using the help of *Atlas.tl software* version 9. Software-assisted research data analysis aims to facilitate the organization of files during the analysis process so as to facilitate the determination of research concept maps by producing novelty (Mahmudah, 2021). The analysis procedure used to analyze the findings of publications that have been carried out comes out by creating a research code. This aims to get a deep novelty from various perspectives that have been carried out by researchers in the publication of research results that can be used as a basis for the analysis of this study. The codes that have been compiled are then made a concept map of literature review research.

Result

The findings of the articles used in this study can be seen in Table 1. The analysis in this systematic literature review was aided by Atlas.ti software version 9. The analysis was carried out by interpreting the findings of previous research by coding the data that can be seen in Table 2. Based on the results of data analysis, the findings of this study can be seen in Figure 1.

Tabel 1. Article Finding

No.	Author	Title	Country
1	(Guo, Saab, Post, & Admiraal, 2020)	A review of project-based learning in higher education: Student outcomes and measures	Netherlands
2	(Chen & Yang, 2019)	Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators	Netherlands
3	(Mursid, Saragih, & Hartono, 2022)	The Effect of the Blended Project-Based Learning Model and Creative Thinking Ability on Engineering Students' Learning Outcomes	United States
4	(MacLeod & van der Veen, 2020)	Scaffolding interdisciplinary project-based learning: a case study	Eropa
5	(Solihatin & Syahrial, 2019)	The effects of Brain-based learning and Project-based learning strategies on student group mathematics learning outcomes student visual learning styles	Serbia, United Kingdom
6	(Parno, Nur'aini, Kusairi, & Ali, 2022)	Impact of The STEM approach with formative assessment in PjBL on students' critical thinking skills	United Kingdom
7	(Li, Wang, Xiao, & Froyd, 2020)	Research and trends in STEM education: A systematic review of journal publications	Jerman
8	(Li & Schoenfeld, 2019)	Problematizing teaching and learning mathematics as "given" in STEM education	Jerman
9	(Stehle & Peters-Burton, 2019)	Developing student 21st Century skills in selected exemplary inclusive STEM high schools	Jerman
10	(Martynenko et al., 2023)	Exploring attitudes towards STEM education: A global analysis of university, middle school, and elementary school perspectives	Eurasia

11	(Tipani, Toto, & Yulisma, 2019)	Implementasi model PjBL berbasis STEM untuk meningkatkan penguasaan konsep dan kemampuan berpikir analitis siswa	Indonesia
12	(Lydiati, 2019)	Peningkatan kreativitas peserta didik pada materi statistika melalui model pembelajaran PjBL-STEM kelas xii mipa 6 sma negeri 7 yogyakarta	Indonesia
13	(Diana & Sukma, 2021)	The effectiveness of implementing project-based learning (PjBL) model in STEM education: A literature review	United Kingdom
14	(Yuliati et al., 2020)	The effect of project based learning-STEM on problem solving skills for students in the topic of electromagnetic induction	United Kingdom
15	(Chistyakov et al., 2023)	Exploring the characteristics and effectiveness of project-based learning for science and STEAM education	Eurasia

Tabel 2. Code List

No.	**Kode**	**No.**	**Kode**
1	Lesson Hours	21	Discussion
2	Individual Responsibility	22	Semester Project
3	Motivation to learn	23	Life Problem Solving
4	Characteristics of Students	24	Problem Analysis Method
5	School Location	25	Product Based Approach
6	Subjects	26	Mind Mapping Approach
7	Field of Subjects	27	Project Based Learning
8	Technology Support	28	STEM Approach
9	Critical Thinking Skills	29	Contextual Approach
10	Problem Solving Skills	30	Practice
11	Creative Thinking Skills	31	Affective
12	Procedural Skills	32	Psychomotor
13	Communication	33	Cognitive
14	Research	34	Improve Learning
15	Reflection	35	Academic Achievement
16	Discovery	36	Learning Outcomes
17	Application	37	Collaboration Improvement
18	Science Learning	38	Professional Skills Improvement
19	STEM Learning	39	Discipline Improvement
20	Product Creation		

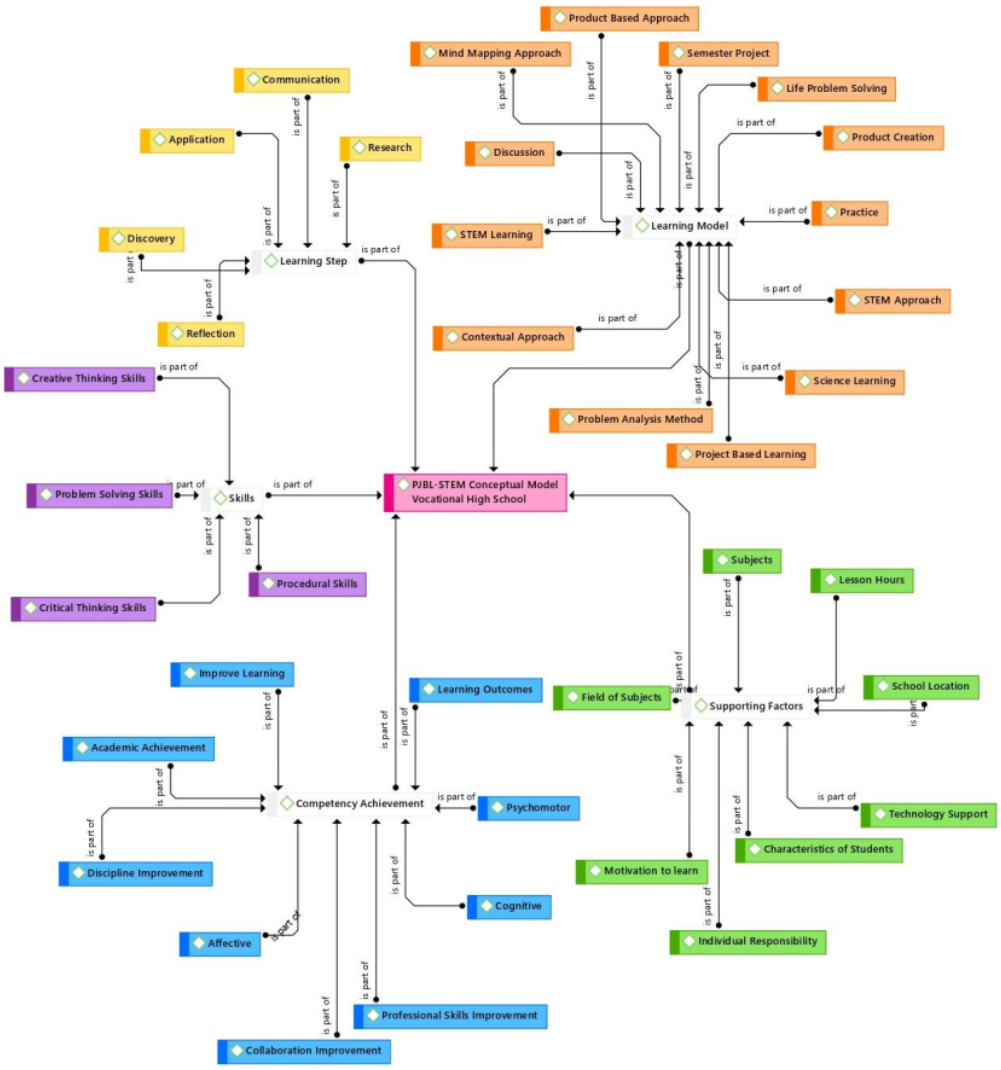

Figure 1. Novelty PjBL Conceptual Model Vocational Education

Discussion

The PjBL approach is used as a learning method that can help the process of critical and creative thinking, raising problem issues in the community. Students play a role in solving problems in accordance with their scientific fields. Based on the findings of the research results / concept map produced, this study has a novelty consisting of five components in the PjBL-STEM learning model in SMK, namely the learning model component, learning step, skills, supporting factors and competency achievement.

In the learning models component, categorization is found to include STEM approach, science learning, project-based learning, problem analysis method, contextual approach, STEM learning, discussion, mind mapping approach, product based approach, semester project, life problem solving, product creation and practice. In the learning step component, categorization of reflection, research, discovery, application, and communication is found. In the skills component, categorization is found to include creative thinking skills, problem solving skills, critical thinking skills and procedural skills. In the supporting factors component, categorization is found to include subjects, field of subjects, lesson hours, school location, technology support, characteristics of students, individual responsibility and motivation to learn. In the competency achievement component, categorization is found to include learning outcomes, psychomotor, cognitive, professional skills improvement, collaboration improvement, affective, discipline improvement, academic achievement and improve learning.

Based on five components in the conceptual model of PjBL-STEM learning in SMK, each indicator has findings that can be used as a focus in the implementation of learning. It can be discussed specifically as follows:

Learning Model

Indicators found from the conceptual model of PjBL learning in vocational schools in the learning model component consist of STEM approach, science learning, project-based learning, problem analysis method, contextual approach, STEM learning, discussion, mind mapping approach, product-based approach, semester project, life problem solving, product creation and practice. These findings are relevant to the theoretical study of Guo et al. (2020) "The creation of products is of importance because it helps learners to integrate and reconstruct their knowledge, discover and improve their professional skills, and increase their interest in the discipline and the ability to work with others". MacLeod dan van der Veen (2020) "problem design can be an extremely important issue in the context of interdisciplinary project-based learning and can make a difference". Likewise, learning models can also be developed through collaborative learning (Abdurrahman et al., 2023). Solihatin dan Syahrial (2019) said.

> "The literature study of the BBL and PjBL strategy concepts described above shows that each has the advantage of improving the quality of learning outcomes in groups of students with appropriate individual characteristics because both are based on constructivism where students construct concepts with mind map approaches for Brain-Based learning strategies Learning (BBL) and product-based approach to Project Based Learning (PjBL) learning strategies".

Parno et al. (2022) "Through discussions during project trials, students are trained to develop reasoning indicators, test hypotheses in the form of interpreting relationships between variables, and analyze possibilities and uncertainties to assess the achievement of STEM aspects". Li dan Schoenfeld (2019) "that STEM disciplines as practiced, are living, breathing fields of inquiry. Knowledge is important; ideas are important; practices are important". Tipani et al. (2019) "In project-based learning students understand concepts by making products, whereas in STEM learning there is a design and redesign process (engineering design process) which makes students produce the best products". Yuliati et al. (2020) "In PjBL-STEM class, students needed to test and refine the performance of the product".

Learning Step

The indicators found from the conceptual model of PjBL learning in vocational schools in the learning step component consist of reflection, research, discovery, application, and communication. These findings are relevant to the theoretical study of Stehle dan Peters-Burton (2019)

> "While assessing the lesson plans, we noted that more explicit instructions in the teacher lesson plans would have resulted in higher rubric scores. Placing students in groups, structuring peer feedback, and having students design a final project for a particular audience are three small changes not seen frequently in the lesson plans that are articulated in the Lesson Plan rubrics to encourage multiple 21st Century skills".

Lydiati (2019) "The stages in PjBL that students go through starting from reflection, research, discovery, application, and communication train students to think and produce creative ideas". Tipani et al. (2019) "In the PjBL learning model, there is a syntax that can improve students' mastery of concepts and analytical thinking skills, namely in the third syntax, namely Discovery". Diana dan Sukma (2021) "The syntax in the PjBL which includes planning, creating, processing, and evaluating has similarities with the steps in implementing STEM learning". Yuliati et al. (2020) said:

> "Students in PjBL class built a product of science to finish certain problem. Students shared their opinions and analysed them to determine which to be included into the project. In groups, students performed testing to refine their products in front of the class while getting feedback and critics to improve the product. Students can also give estimation about price of the product at the market. This is different with PjBL where students are not as active. They were instructed to finish the pre-determined project given by the teacher and then present it. When one group was explaining their work, others were only permitted to share their criticism or comments. These different treatments in two classes lead to different set of activities which ended in different change in problem solving skills of students".

Skills

The indicators found from the conceptual model of PjBL learning in vocational schools in the skills component consist of creative thinking skills, problem solving skills, critical thinking skills and procedural skills. These findings are relevant to the theoretical study of Parno et al. (2022) "The STEM approach with formative assessment in PjBL has a significant positive impact in building students' critical thinking skills on static fluid material". Lydiati (2019) "Through the PjBL-STEM learning model, students are trained to be able to fluently express ideas in solving statistical problems they face, have various ideas in solving these problems, then combine new knowledge with the knowledge they already have". Tipani et al. (2019) "implementation of the STEM-based PjBL model can improve students' mastery of concepts and analytical thinking abilities". Diana dan Sukma (2021) "The effectiveness of the application of PjBL in STEM learning can improve students' abilities, both cognitive, affective and psychomotor". Kajian teori dari Chistyakov et al. (2023) "PjBL can be categorized as a learning model that can improve student learning outcomes in science learning and train students in problem solving (critical thinking)". Likewise, it is related to up-skilling and re-skilling which can be used as a reference in developing learning competencies (Mahmudah et al., 2021).

Supporting Factors

The indicators found from the conceptual model of PjBL-STEM learning in vocational schools in the supporting factors component include subjects, field of subjects, lesson hours, school location, technology support, characteristics of students, individual responsibility and motivation to learn. These findings are relevant to the theoretical study from Chen dan Yang (2019) "The findings of this meta-analysis suggest that students' academic achievement 20 in PjBL is not affected by educational stage and group size, but by subject area, school location, 21 hours of instruction, and information technology support". Mursid et al. (2022) "Applying learning motivation for success and individual responsibility is important to support the effectiveness of the blended PjBL model, as these two factors encourage students to help each other during learning". Stehle dan Peters-Burton (2019) "We also saw in the lesson plans that ICT provides tools to support communication and reflection which leads to knowledge construction and real-world problem solving".

Competency Achievement

The indicators found from the conceptual model of PjBL-STEM learning in vocational schools in the achievement competency component include learning outcomes, psychomotor,

cognitive, professional skills improvement, collaboration improvement, affective, discipline improvement, academic achievement, and improved learning. These findings are relevant to the theoretical study of Guo et al. (2020) "Project-based learning (PjBL) is understood to be a promising approach that improves student learning in higher education. Empirical studies on project-based learning have been reviewed with a focus on student outcomes". Theoretical study of Mursid et al. (2022) "Enhancing students' learning outcomes in engineering drawing can help them achieve a high quality of life and knowledge in their field, solve social problems, develop their interests and talents, and adapt to the necessary science and technology development in the 21st century". Stehle & Peters-Burton (2019) "collaboration was the only ru- bric metric where the short-term lessons averaged a higher collaboration score than the long-term lessons. Evidence from the lessons show students worked in pairs or groups, but infrequently shared responsibility, made deci- sions together, or worked interdependently". Lydiati (2019) "The increase in student learning achievement through the application of a contextual approach in Mathematics learning is caused by the following things". Diana dan Sukma (2021) "The effectiveness of using the PjBL learning model in STEM education is generally supported by its characteristics. Based on the review of seven journals that link PjBL and STEM, it is known that PjBL is one of the learning models which is significantly appropriate to be implemented in STEM education to increase the effectiveness of this approach".

Conclusion

Based on the results of research and discussion can be concluded that project-based learning is the development of methods and strategies that can be used to improve and improve the quality of learning. At the vocational or vocational education level, project-based learning is a must for improving skills and competencies both in terms of mastery of service and product expertise competencies. The findings of this research are important to be used as a basis for teachers in vocational education units to be able to develop themselves through various indicator approaches that become novelty. This research recommendation is for vocational education units, especially school principals and productive teachers to be able to develop learning competencies through the right approach in accordance with student needs and the relevance of competencies expected by the industry. In the end, the learning process carried out can be used as capital and basis for students and graduates for employment and absorption of graduates.

Author contribution statement

Aliyah: Conceptualization of literature review research; Fitri: Manuscript, Data Analysis, Discussion

Declaration of interests statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper. Alternatively, The authors declare the following financial interests/personal relationships, which may be considered as potential competing interests.

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Project-Based Learning Concept Map in Vocational Education

ORIGINALITY REPORT

14%	%	14%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Parno, L Yuliati, N Munfaridah, M Ali, F U N Rosyidah, N Indrasari. "The effect of project based learning-STEM on problem solving skills for students in the topic of electromagnetic induction", Journal of Physics: Conference Series, 2020 Publication	2%
2	Veronica Livescu, Cameron M. Knapp, George T. Gray, Ramon M. Martinez, Benjamin M. Morrow, Bineh G. Ndefru. "Additively Manufactured Tantalum Microstructures", Materialia, 2018 Publication	1%
3	Wuri Julita, Rahmadhani Fitri, Fitri Arsih. "Meta-Analysis: The Effect of Implementing the STEM (Science, Technology, Engineering, Mathematics) Approach on Biology Learning", Journal of Digital Learning and Education, 2022 Publication	1%

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