
Meta-Analysis in Measuring the Effectiveness of Problem-Based Learning Models in Vocational Education**Rosi Yulianti¹, Asmar Yulastri², Ambiyar³, M Giatman⁴**rosiyulianti@gmail.com^{1,2,3,4} Universitas Negeri Padang

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Abstract

Introduction to learning models is key to discussing the approaches used to transfer knowledge and skills to students. Learning models encompass various strategies and approaches designed to create an effective learning environment and stimulate intellectual and social development, particularly in vocational education. Therefore, this research will explore the effectiveness of one learning model in vocational education, namely Problem-Based Learning (PBL). This study implements the meta-analysis method by synthesizing data from 15 research articles from 2019 to 2023. Using secondary data from Classroom Action Research (CAR) studies, this research calculates the effect size to determine the impact of the PBL model on learning outcomes. The results, presented graphically, show a significant effect size (1.02), indicating a very high impact of the PBL model in vocational education. The discussion emphasizes factors contributing to this effectiveness, including a focus on student autonomy, the development of soft skills, and alignment with the demands of the vocational workforce. Overall, the PBL model emerges as a highly effective approach in improving learning outcomes and preparing vocational education students for real-world challenges.

A. Introduction

Education is a multifaceted and crucial process that involves the acquisition of knowledge, skills, values, and attitudes. It is a lifelong journey that occurs formally in schools, colleges, and universities, as well as informally through experiences and self-directed learning [1], [2]. Education plays a fundamental role in individual and societal development by empowering people to understand the world, make informed decisions, and contribute to the betterment of society. Higher education is an integral part of the aforementioned educational journey [3]. It provides individuals with the opportunity to delve deeper into complex concepts, sharpen analytical skills, and prepare themselves for more profound contributions to society and the workforce [4].

Vocational or technical education is also a crucial component in the broader context of education. Alongside higher education, vocational education provides a valuable alternative for developing practical skills and knowledge [5]. Vocational programs prepare individuals to enter the workforce with skills that can be directly applied in the field [6], [7]. Vocational education encompasses training in various industries and specific fields such as engineering, technology, healthcare, and many more. Students in vocational education not only acquire technical knowledge but also practical skills relevant to industry needs [8]. This is reinforced through various learning models that support the development of knowledge, skills, values, and attitudes [9]. Among the numerous learning models, one that plays a significant role in enhancing student knowledge is the problem-based learning model, which is instrumental in deepening understanding within the chosen field.

Problem-Based Learning (PBL) is one of the learning approaches that focuses on problem-solving through real-world situations or challenges [10]. In the context of PBL, students are presented with a complex case or problem that requires critical thinking and investigation. Guiding questions are then directed towards students to stimulate analytical thinking and further exploration. This approach aims to develop Higher Order Thinking Skills (HOTS), creativity, and teamwork, while strengthening the connection between conceptual knowledge and its application in real life [11], [12]. By placing students in an active and contextual role, PBL creates a learning environment that prepares them to face the complexities of the real world and develop skills relevant to the future.

Examining the advantages of the Problem-Based Learning (PBL) model that can accommodate learning in the era of the 4th industrial revolution and enhance students' Higher Order Thinking Skills (HOTS), the PBL model is highly relevant for utilization in vocational education. This need arises from the fact that vocational education is expected to produce graduates ready for the workforce or entrepreneurship, requiring critical thinking abilities, practical skills, and the utilization of information technology in line with their specific field. Therefore, this study aims to examine the effectiveness of the PBL model when applied in vocational education.

B. Research Method

The method employed in this research is meta-analysis, which is a statistical research method used to integrate and analyze the results of several empirical

studies conducted on a specific topic or research question [13]. The goal is to provide a quantitative synthesis of these findings, offering a more comprehensive overview of the effect of a variable or intervention than what could be derived from an individual study [14]. In the execution of this meta-analysis, the use of secondary data becomes a critical aspect, involving post-test values from both experimental and control groups in previously conducted research. The secondary data is derived from research articles implementing the Classroom Action Research (CAR) method with a Problem-Based Learning (PBL) model in the context of vocational education. Meta-analysis allows for a systematic examination of these collective findings, facilitating a more nuanced understanding of the overall impact of the PBL model on learning outcomes in vocational education. This method enables researchers to draw more robust conclusions by synthesizing data from multiple studies and identifying patterns or trends that may not be apparent in individual research endeavors.

By incorporating secondary data from post-test scores of both the experimental and control groups, there are advantages in amalgamating findings from various similar studies to obtain a more holistic and general overview of the effects of the PBL model in vocational education. The process of meta-analysis for this type of data involves the extraction and processing of existing data, followed by statistical analysis to synthesize these findings.

The research articles selected for this study are sourced from national and international journals spanning the years 2019 to 2023. A total of 15 research articles have been included, covering various concentrations within vocational education globally. Subsequently, the obtained data will be calculated using the following effect size formula.

$$ES = \frac{M_e - M_c}{SD}$$

Explanation:

ES = Effect Size value

M_e = Mean value of the experimental group

M_c = Mean value of the control group

SD = Pooled standard deviation value

Afterward, to obtain the pooled standard deviation value, it is calculated using the following formula for SD pooled.

$$SD_{pooled} = \sqrt{\frac{(N_e - 1)SD_e^2 + (N_c - 1)SD_c^2}{N_e + N_c - 2}}$$

After obtaining the SD pooled value, the next step is to subtract the mean value of the experimental group from the mean value of the control group and then divide it by the standard deviation. The calculated result will yield an outcome that is then interpreted using an effect size category table. Based on this interpretation, the treatment effect category is obtained, in this case, for the PBL model in vocational education. Table 1 represents the categories of effect size as follows:

Table 1. The criteria for Effect Size

Large Effect Size	Description
0,00 – 0,20	Has a weak effect
0,21 – 0,50	Has a low effect
0,51 – 1,00	Has a moderate effect
> 1,00	Has a high effect

Source: K. Cohen, L., Manion, L., & Morrison [15].

C. Result and Discussion

After conducting a review of 15 research articles utilizing the PBL model in vocational education, the post-test results data were collected. This data originated from the learning outcomes of the control and experimental groups in Classroom Action Research (PTK) studies as presented in the research articles on vocational education. The obtained data is presented in Table 2.

Table 2. Meta-analysis data

No.	Authors	Year	Title	Post Test	
				Experiment	Control
1.	Muhammad Nurtanto, Moh Fawaid, Herminarto Sofyan	2019	Problem Based Learning (PBL) in Industry 4.0: Improving Learning Quality through Character-Based Literacy Learning and Life Career Skill (LL-LCS) [16]	87,64	82,37
2.	Noor H. Jabarullah, Hafezali Iqbal Hussain	2019	The effectiveness of problembased learning in technical and vocational education in Malaysia [17]	79,8	60,2
3.	Reny Murni Hidayati, Wagiran	2020	Implementation of Problem-Based Learning to Improve Problem-Solving Skills in Vocational High School [18]	73,07	69,08
4.	Tri Murhanjati Sholihah, Badraningsih Lastariwati	2020	Problem based learning to increase competence of critical thinking and problem solving [19]	87,68	84,29
5.	Sukatiman, M. Akhyar, Siswandari, and Roemintoyo	2020	Enhancing Higher-Order Thinking Skills in Vocational Education through Scaffolding Problem Based Learning [20]	83,03	74,62
6.	Rohatin Arpianingsih	2020	Peningkatan Hasil Belajar Peserta Didik Kelas XII SMKN 1 Sakra Pada Materi Pengolahan Hasil Hewani Melalui Penerapan Model Pembelajaran Berbasis Masalah [21]	88,89	66,67
7.	Sulaeman Deni Ramdani, R. Ahmad Zaky El Islami, Herlina Pratiwi, Moh Fawaid, Haris Abizar, Ismi Maulani	2021	Developing digital teaching material on basic electricity based on problem-based learning in vocational education [22]	67	39,7
8.	Yusuf	2022	Peningkatan Hasil Belajar Akuntansi Keuangan Melalui Pembelajaran Berbasis Masalah	82,18	73,06

			pada Siswa Kelas XI AKL3 SMK Negeri 1 Sinjai [23]		
9.	Khoirul Huda	2022	Peningkatan Prestasi Belajar Aplikasi Pengolah Angka dengan Model Pembelajaran Berbasis Masalah [24]	83,27	73,42
10.	Sugeng Susanto, Wagino, Donny Fernandez, Hendra Dani Saputra, Alfian Asra	2023	Meningkatkan Hasil Belajar Pemeliharaan Mesin Sepeda Motor Melalui Model Pembelajaran Problem Based Learning Pada Siswa Kelas XI TBMS SMKN 3 Solok Selatan [25]	76,17	63,28
11.	Irfan Tarius Ginting, Verry Ronny Palilingan, Olivia Eunike Selvie Liando	2023	Model Pembelajaran Berbasis Masalah untuk Meningkatkan Hasil Belajar Pemrograman Dasar Siswa Kelas X TKJ Di SMK Negeri 3 Tondano [26]	81,76	74,07
12.	Gebriany Saradipta Aryanto, Verry Ronny Palilingan, Jimmy Waworuntu	2023	Penerapan Model Pembelajaran Berbasis Masalah untuk Meningkatkan Hasil Belajar Administrasi Infrastruktur Jaringan Siswa Kelas XI TKJ SMK Cokroaminoto Kotamobagu [27]	82,93	79,48
13.	Fitriani	2023	Upaya Meningkatkan Hasil Belajar Fisika Melalui Model Pembelajaran Berbasis Masalah (Problem Based Learning) Pada Siswa Kelas X TKJ 2 SMK Negeri 1 Lhokseumawe Tahun Pelajaran 2020-2021 [28]	98,3	88,17
14.	Yakob Juwanjao Linu, Jimmy Waworuntu, Christine Takarina Meitty Manoppo	2023	Pengaruh Model Pembelajaran Berbasis Masalah terhadap Hasil Belajar Administrasi Infrastruktur Jaringan Siswa Kelas XI TKJ SMK Negeri 1 Mopuya [29]	83,28	77,21
15.	Refna Yetti	2023	Model Pembelajaran Project Based Learning Meningkatkan Hasil Belajar Mata Pelajaran Komputer Akuntansi (Studi Kasus: SMK Negeri 1 Solok) [30]	87	80,47

Next, to assist in analyzing the tabulation of post-test data from Table 2, the tabulated post-test data is presented in the form of a graph. The graph representing the tabulated post-test learning outcomes data is as follows.

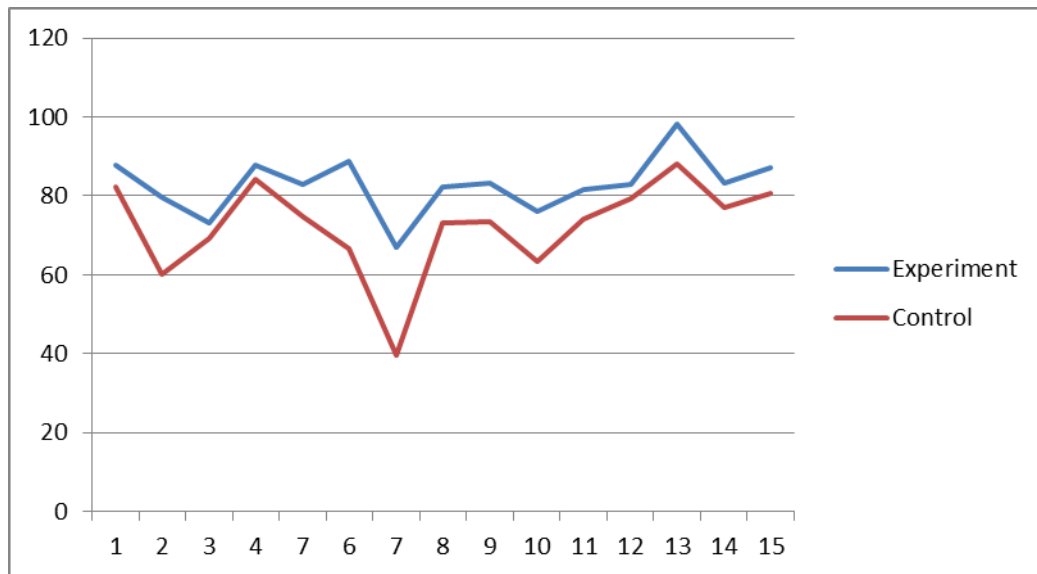


Figure 1. Tabulation of Meta-Analysis Data (Post-Test)

Based on the collected post-test scores from the experimental and control groups, the average score for the experimental group is 82.25, while the average score for the control group is 70.85. After calculating the effect size using the formula, the final value obtained is 1.02. When interpreting this value with reference to the effect size criteria table, it can be concluded that the Problem-Based Learning (PBL) model has a very high effect on learning outcomes in vocational education [31].

The high effect of the PBL model can be explained by several factors. One of them is the focus on student autonomy in learning. The PBL model encourages students to take an active role in the learning process, prompting them to explore course material more deeply outside the classroom. This creates a learning environment that fosters curiosity and intrinsic motivation among students. This student-centered approach also involves the development of soft skills, including critical thinking, teamwork, and communication. The PBL model provides opportunities for students to collaborate in addressing real-world problems, strengthening crucial interpersonal skills for the workforce.

Therefore, the high effect of the PBL model in vocational education can be understood as a result of the combination of promoting student autonomy, developing soft skills, and the model's relevance to the demands of the vocational workforce. Overall, the PBL model proves itself as an effective learning approach in enhancing learning outcomes and preparing students to face challenges in the vocational world.

D. Conclusion

The Problem-Based Learning (PBL) model has a highly significant effect on learning outcomes in vocational education. This is based on the calculation results from research data, which yielded an effect size value of 1.02. A value of 1.02 is interpreted as a very high effect of the PBL model on learning outcomes in vocational education. The high effectiveness of the PBL model is influenced by student-centered factors, encouraging students' critical thinking, and the incorporation of cutting-edge technology within the PBL model. This makes the

PBL model highly effective in the vocational education learning process, producing graduates who are ready for the workforce or entrepreneurship.

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