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Analysis of Problem Based Learning Implementation for Enhancing Vocational High School Students Critical Thinking Skills

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Abstract
Students' critical thinking skills remain relatively low because the learning process tends to be teacher-centered. This situation highlights the need to implement a learning model that can enhance students' active participation during learning activities. This study aims to examine the effectiveness of implementing Problem Based Learning (PBL) in improving students' critical thinking skills through a Systematic Literature Review (SLR). The study was conducted in accordance with the PRISMA 2020 guidelines, which include the stages of identification, screening, eligibility, and included studies. Articles were searched in the Google Scholar, Scopus, and DOAJ databases, covering publications from 2023 to 2025. A total of 30 articles were selected based on inclusion and exclusion criteria and then analyzed using narrative synthesis. The results indicate that the implementation of PBL generally has a positive impact on enhancing students' critical thinking skills, as evidenced by improved learning outcomes, student engagement in the learning process, problem-solving abilities, and peer collaboration. The novelty of this study lies in the integration of the latest research findings regarding the effectiveness of PBL for vocational high school students based on publications from 2023 to 2025. However, the implementation of PBL still faces several obstacles, such as limited learning time and teachers' readiness to implement Problem Based Learning.

Keywords
Critical Thinking; Problem Based Learning; Vocational Education

INTRODUCTION

Critical thinking is a fundamental competency required of every individual in navigating the complexities of the 21st century. In the context of vocational education, this need is increasingly urgent, given that graduates of vocational high schools (SMK) are

expected to enter a highly dynamic and competitive job market directly. Vocational high school education plays a strategic role in preparing a workforce that is not only technically competent but also capable of critical, analytical, and adaptive thinking in response to changes in the industrial world (Ana Latifah et al., 2025). The 4C skills Critical Thinking, Collaboration, Communication, and Creativity have become the competency standards required by modern industry and serve as the primary foundation for the development of the Merdeka Curriculum in Indonesia (Effendi et al., 2024). However, empirical data indicates that Indonesian students' critical thinking proficiency remains concerning: according to the 2022 Programme for International Student Assessment (PISA) results, Indonesia ranked 68th out of 81 participating countries, suggesting that students' higher-order thinking skills have not developed optimally (OECD, 2023).

At the vocational high school (SMK) level, the issue of low critical thinking skills has been consistently documented in various studies. The critical thinking skills of SMK students generally remain in the low category, with the most prominent deficiencies in the evaluation and inference indicators. A similar situation was revealed in a recent study showing that the average scores for indicators of students' critical thinking skills, including evaluation (34.62) and inference (30.77), both fall into the very low category (Sakila et al., 2026). The root of this problem lies in teaching practices that are still dominated by conventional, teacher-centered approaches: lecture methods, a lack of problem-solving activities, and a rote-learning-oriented curriculum are the primary external factors hindering the development of students' critical thinking (Rofi'ah et al., 2024). This situation is exacerbated by the fact that most vocational high school teachers do not yet understand the concepts or implementation of innovative learning models oriented toward the development of higher-order thinking skills (Mustaji et al., 2024). Furthermore, learning assessments in vocational high schools generally still focus on lower-order cognitive aspects, so graduates' critical thinking and psychomotor skills have not been comprehensively measured or developed (Didaktika, 2025).

In response to these challenges, the Problem Based Learning (PBL) model has garnered widespread attention as a learning approach proven to be effective in developing critical thinking skills. PBL is a student-centered learning model in which real-world problems serve as the context and starting point for the learning process, encouraging students to think critically, collaboratively, and creatively in finding solutions (Ismail &

Imawan, 2024). In the context of vocational high schools, various studies indicate that the systematic implementation of PBL significantly enhances students' critical thinking skills compared to conventional instruction. Meanwhile, Ana Latifah et al. (2025) concluded that integrating PBL into vocational education effectively helps students develop problem-analysis skills, solution-evaluation skills, and team collaboration skills. Nelsya et al. (2025) also emphasize that PBL integrated with information technology within the framework of the Merdeka Curriculum can create an active, collaborative learning ecosystem that optimally fosters students' critical-analytical abilities.

These various studies indicate that PBL holds great potential for enhancing the critical thinking skills of vocational high school students. However, most studies still focus on measuring quantitative learning outcomes and academic score improvements alone, thus failing to provide a deep explanation of how the PBL implementation process unfolds in vocational education, which has distinct characteristics from general education.

Although the literature on PBL in vocational high schools has grown, several substantial research gaps remain unaddressed. First, most previous studies have been limited to measuring the cognitive domain alone, without in-depth exploration of the psychomotor and affective aspects, which are actually the core of vocational competencies; Effendi et al. (2024) themselves acknowledge that such cross-domain research remains very rare in the context of technical and vocational education. Second, studies specifically analyzing the application of PBL within the framework of the Merdeka Curriculum in vocational high schools remain very limited, even though the dynamics of implementing this new policy present challenges and opportunities that have not yet been comprehensively captured (Rahmawati & Kusuma, 2023). Third, most previous studies have merely positioned PBL as a learning strategy to improve learning outcomes, without analyzing the relationship between PBL syntax, vocational learning characteristics, and the development of students' critical thinking skills in a comprehensive manner. Fourth, qualitative or mixed-method approaches which can capture the depth of meaning behind the PBL implementation process and the on-the-ground experiences of teachers and studentsare still rarely used, resulting in a superficial understanding of the mechanisms of how and why PBL succeeds or fails in vocational high schools (Suhaedin et al., 2024). Furthermore, comparative research across vocational programs that can demonstrate differences in the effectiveness of PBL implementation across various vocational fields

remains limited, even though the characteristics of each vocational program significantly influence the learning process and the development of students' critical thinking skills.

To address this gap, this study offers a novel approach in the form of an analysis of PBL implementation in vocational high school education within the context of the Merdeka Curriculum, which not only focuses on improving learning outcomes but also examines the relationship between the learning process, the characteristics of vocational education, factors supporting and hindering implementation, and the development of students' critical thinking skills based on six standard indicators. The novelty of this study lies in its effort to provide a more comprehensive understanding of the mechanisms of PBL implementation in vocational high school settings through a literature review approach focused on synthesizing research findings, rather than merely describing previous studies.

Based on the identified research gaps, this study aims to: (1) describe and analyze the application of the PBL model in vocational high school learning within the framework of the Merdeka Curriculum; (2) analyze the improvement of vocational high school students' critical thinking skills through the application of PBL based on six measurable indicators; (3) identify the supporting and inhibiting factors for PBL implementation in vocational high schools; and (4) formulate strategies for optimizing the application of PBL that are contextual and evidence-based. The findings of this study are expected to contribute to the development of teaching practices in vocational high schools, particularly in preparing graduates who are critical thinkers, adaptable, and competent in facing the challenges of the 21st-century workplace.

This situation indicates that learning in vocational high schools requires teachers to select models capable of encouraging active student engagement and developing critical thinking skills. One model that can be used is Problem Based Learning, which focuses on solving real-world problems to enhance students' critical thinking skills. Given the various challenges in the learning process, this study was conducted through a literature review to examine the impact of PBL implementation on critical thinking skills and learning outcomes among vocational high school students. The objective of this study is to determine the extent to which the implementation of PBL can improve students' critical thinking skills and learning outcomes.

METHOD

This research applies the Systematic Literature Review (SLR) method to examine, collect, and synthesize various research findings regarding the impact of Problem Based Learning on critical thinking skills and the learning outcomes of vocational high school students. The research was conducted in accordance with the PRISMA 2020 guidelines, which include the stages of identification, screening, eligibility, and included studies. The literature search was conducted through several academic databases, namely Google Scholar, Scopus, DOAJ (Directory of Open Access Journals), and national journal portals using the keywords “Problem Based Learning,” “critical thinking,” and “vocational high school.”

The inclusion criteria for this study encompassed empirical research articles on the implementation of Problem Based Learning among vocational high school students, published in national or international journals from 2023 to 2025, available in full-text format, and relevant to the study variables. Exclusion criteria include literature review articles, studies at educational levels other than vocational high schools, articles that are not fully accessible, and studies that combine PBL with other learning models without specifically explaining the impact of PBL.

Articles meeting the criteria were then analyzed using narrative synthesis to compare, categorize, and interpret research findings regarding the impact of PBL on vocational high school students’ creative thinking, critical thinking, and learning outcomes. The data extraction phase involved gathering key information from each article, such as author names, publication year, research methods, sample, research instruments, and research results. Article quality was assessed based on the clarity of the research objectives, the appropriateness of the research methods, the validity of the instruments, and the data analysis techniques used. The research results were then presented in the form of descriptive narratives and a PRISMA flow diagram.

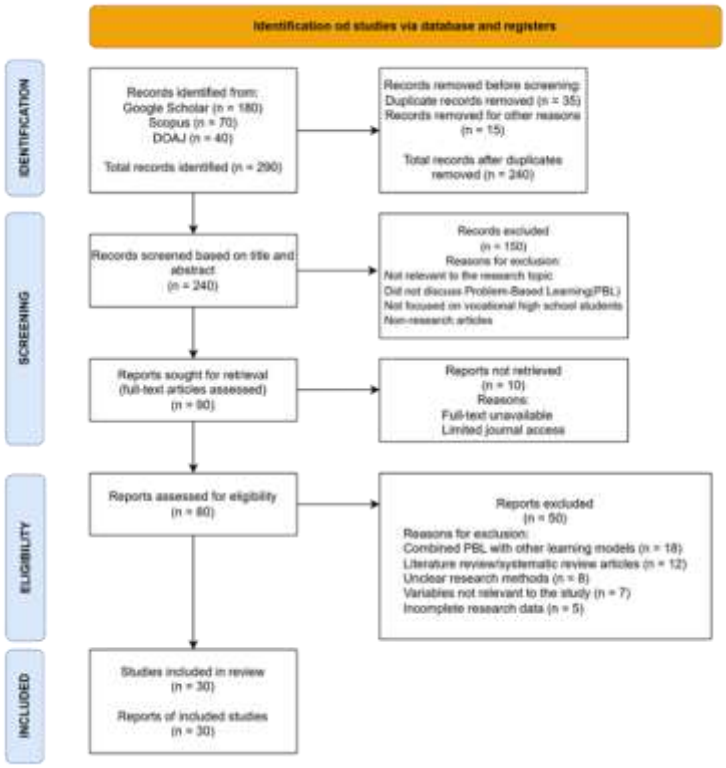

Figure 1. PRISMA Flowchart of Literature Selection

RESULT AND DISCUSSION

In this literature review, the research data presented are the results of an analysis of 30 sample articles relevant to the topic of this study. The selected articles are those that include the keywords "Problem Based Learning," "Critical Thinking," and "Vocational High School." Furthermore, each article was analyzed based on its research focus, methods, and findings regarding the application of Problem Based Learning in enhancing the critical thinking skills of vocational high school students. The results of the article analysis are presented in the Figures 2 and Tables 2.

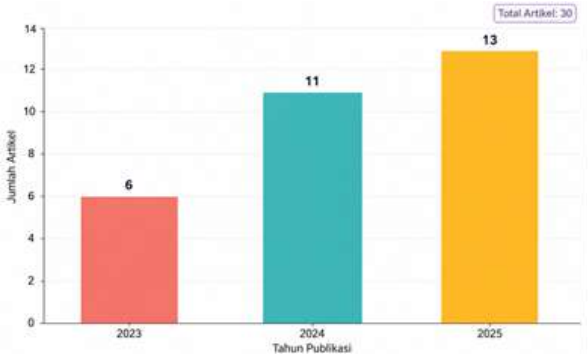

Figure 2. Bar Chart of Articles by Publication Year

Table 2. Characteristics of Reviewed Studies

No	Author	Judul Penelitian	Hasil
1	Niluh Sulistyani & Nadia Rustyningsih (2024)	Analisis Keterampilan Berpikir Kritis dan Kreatif Siswa SMK Kelas XI dalam Pembelajaran Matematika Berbasis PBL	This study shows that students' critical thinking skills in PBL reached the "fairly critical" category. This category was determined based on the average student scores within a single class as well as the majority of categories. The average pretest score was 28.40 in the control class and 36.04 in the experimental class. After being treated with the Problem Based Learning model, there was a difference in the average percentage of indicators of students' critical thinking skills on the posttest: the experimental class scored 81.54, falling into the "very good" category, while the control class scored 67.84, falling into the "good" category.
2	Ana Latifah, Muhammad Nur Fuad, Annisa Sholikhatul Fatih, &Fata Farihi Ramadhan (2025)	Integrasi Problem Based Learning dalam Pembelajaran Kejuruan untuk Meningkatkan Keterampilan Berpikir Kritis Siswa SMK Merdeka Ulujami	This study demonstrates that the Problem Based Learning (PBL) approach is effective in enhancing the critical thinking skills of vocational high school students, particularly in terms of analysis, evaluation, and collaboration. Observation results indicate that after implementing the PBL model, students became more active in the learning process. They demonstrated improvements in identifying problems, analyzing information, and proposing more creative solutions. Compared to conventional methods, PBL enables students to think more independently and become more engaged in discussion-based and group-work learning.
3	Endah Kurniawati, Eko Hariadi, & Achmad Imam Agung (2025)	Dampak Penerapan Model Problem Based Learning dan Berpikir Kritis untuk Meningkatkan Kemampuan Numerik Matematika	This study shows that the control class had a 10.09% increase in scores, while the experimental class had a 25.55% increase. The results of the independent sample test also showed a significance level of 0.00 < 0.05, indicating a significant difference between the experimental and control classes. Therefore, the implementation

			of the Problem Based Learning model and critical thinking has a significant impact on improving students' numerical skills.
4	Hadi Hasan & Hepsi Nindiasari (2023)	Efektivitas Problem Based Learning (PBL) untuk meningkatkan kemampuan berpikir kritis siswa di SMK Negeri 2 Pandeglang	This study examined the effectiveness of enhancing students' critical thinking using the Problem Based Learning model on their mathematical critical thinking skills in statistics. The Problem Based Learning model can improve critical thinking skills by 83.4722, while the lecture (conventional) model can improve critical thinking skills by 66.0000, which means there is a difference between the two models because Problem Based Learning is more effective than the lecture (conventional) model.
5	Fadhilatun Ni'mah, Slamet Asari, & Syaiful Huda (2024)	Efektivitas Model Problem Based Learning Terhadap Berpikir Kritis dengan Pembelajaran Berdiferensiasi pada Peserta Didik SMKN 1 Cerme	This study demonstrates that the *Project-Based Learning* (PBL) model is effective in enhancing students' creative thinking skills regarding biodiversity. The study employed a *pre-experimental* design with a single *pretest-posttest* group involving 34 10th-grade MIPA students at SMAN 22 Gowa. The results showed a significant improvement in students' creative thinking skills, with an average *pretest* score of 23 (very low category) and *a posttest* score of 83 (good category). The *n-gain* analysis indicated a 78.53% increase, which falls within the effective category
6	Bernadeta Winda Putri Permatasar &, Binti Muchsini (2025)	Pengaruh PBL Berbantuan Quizizz Dalam Pembelajaran PJDM Terhadap Kemampuan Berpikir Kritis Siswa SMK	The research results show that after conducting an independent t-test on critical thinking skills, there was a difference in the critical thinking skills of the experimental and control groups after the treatment. This indicates that students' critical thinking skills in the practice of accounting for manufacturing and trading service companies can be improved by using PBL with the assistance of Quizizz.
7	Dian Nur Kharisma & Muhammad Kris	The Application of Problem Based Learning Models on	The results showed that the average posttest score for the control class was 80.69 and for the experimental class was 85.00. The results of the

	Yuan Hidayatulloh (2025)	the Critical Thinking Skills of Vocational School Students	independent sample t-test showed a Sig. (2-tailed) value of 0.038 < 0.05, indicating a significant difference between the use of the Problem Based Learning model and direct instruction. The Problem Based Learning model proved to be more effective in improving the critical thinking skills of vocational school students.
8	Ni Kadek Dwi Sri Lestari, I Putu Pranatha Sentosa, & Ni Made Erpia Ordani Astuti	Differences in Critical Thinking Skills and Student Learning Outcomes Through the Application of Problem Based Learning Models Assisted by Interactive Media	The results showed that the application of the PBL model assisted by interactive media (Quizizz) increased the average critical thinking ability from 82.02 (pretest) to 88.66 (posttest). Additionally, the average student learning outcomes also increased from 71.46 to 83.15. The results of *the paired sample t-test* for both variables showed a Sig. value of 0.000 < 0.05, indicating a significant difference in critical thinking skills and learning outcomes before and after the intervention. The *Problem Based Learning* model supported by interactive media proved effective in increasing the percentage of students who achieved mastery to 100%.
9	Yudistira Putra Harum & Ainun Nadhif	Implementasi Model Problem Based Learning dengan Media Proyektor pada Pembelajaran PAI dan Budi Pekerti di SMK Negeri 3 Buduran	The research results show that the application of the Problem Based Learning (PBL) model combined with a projector creates a more interactive and engaging learning environment. The use of visual media helps students understand the material more concretely, thereby reducing boredom compared to conventional methods. Additionally, student engagement increases, leading to improved conceptual understanding in Islamic Education and Character Education.
10	Faisal Haris, Ikhsanudin, Sulaeman, & Deni Ramdani	Peningkatan Kemampuan Berpikir Kritis Siswa SMK Negeri 3 Kab. Tangerang Melalui Model Pembelajaran Problem Based Learning	The research results indicate a significant improvement in students' critical thinking skills following the implementation of the PBL model. This is evidenced by an increase in the average critical thinking score from 2.14 in the initial cycle to 3.45 in the final cycle. Additionally, posttest scores also showed a substantial increase, from 4.00 to 8.90. This improvement indicates that PBL

			is effective in training students to analyze, evaluate, and solve problems systematically.
11	Arif Nur Rohmad	Peningkatan Kemampuan Teamwork dan Berpikir Kritis Siswa dengan Model Problem Based Learning pada Pembelajaran Praktik Pemeliharaan Mesin Sepeda Motor	The results of the study indicate that the implementation of the PBL model significantly improved students' teamwork and critical thinking skills. Teamwork skills increased by 63%, from 28% at the baseline to 91% after the intervention. Meanwhile, critical thinking skills increased by 70%, from 20% to 90%. This demonstrates that PBL is effective in developing students' collaborative skills and higher-order thinking skills in practical learning.
12	Siska Puji Astutik & Nailariza Umami	Pengaruh Model Pembelajaran Problem Based Learning (PBL) terhadap Kemampuan Berpikir Kritis dan Komunikasi Siswa Kelas X AKL di SMKN 2 Tulungagung	The discussion of the results shows that the PBL model has a significant effect on students' critical thinking and communication skills, as indicated by the hypothesis test results with a significance level of < 0.05. Students who used PBL had higher critical thinking and communication skills compared to the class using conventional learning. This occurred because PBL encourages students to be active in the learning process through discussion and problem-solving. Additionally, students became more skilled at expressing ideas and arguing logically.
13	Yaasin Nurjanah & Hery Sawiji	Implementasi Model Pembelajaran Problem Based Learning (PBL) dalam Upaya Meningkatkan Kemampuan Berpikir Kritis pada Mata Pelajaran Dasar-Dasar Manajemen Perkantoran dan Layanan Bisnis di Kelas X MPLB SMK Wikarya Karanganyar	The research results indicate that the application of the Problem Based Learning (PBL) model is capable of gradually improving students' critical thinking skills through each learning cycle. This improvement is evident in the increasing number of students achieving learning mastery at each session, from Cycle I through Cycle II. Furthermore, the implementation of PBL encourages students to be more active in discussions, express their opinions, and analyze problems more deeply, thereby making learning more effective and student-centered.

14	Putri Regina Agustina, & Soetarno Joyoatmojo	Penerapan Model Pembelajaran Problem Based Learning (PBL) Berbantuan Media Mind Mapping untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas XI Pemasaran 2 SMK Negeri 6 Surakarta	The research results indicate that the implementation of the Problem Based Learning (PBL) model combined with mind mapping media significantly enhances students' critical thinking skills. This improvement is evident from the increase in the percentage of students' critical thinking skills across each learning cycle. The use of mind mapping helps students understand the material in a more structured manner and facilitates the analysis process, thereby making students more active and enabling them to develop their critical thinking skills throughout the learning process.
15	Suryani S. Situmorang & Endang Widjajanti Laksono	Penerapan Problem Based Learning terhadap Kemampuan Berpikir Kritis dan Keaktifan Belajar Peserta Didik	The research results indicate that the implementation of the Problem Based Learning (PBL) model is significantly more effective than the scientific learning approach in enhancing students' critical thinking skills and learning engagement. Students learning through the PBL model demonstrated more active engagement in the learning process as well as better abilities in analyzing and solving problems. Additionally, the PBL model contributes significantly to the improvement of critical thinking and learning engagement, thereby creating more meaningful and interactive learning experiences.
16	Hida Fatimah Alindri, Iskandar, & Novi Satria Pradja	Pengaruh Penggunaan Model Problem Based Learning terhadap Kemampuan Berpikir Kritis Ditinjau dari Kecerdasan Emosional	The research results indicate that the implementation of the Problem Based Learning (PBL) model has a significant impact on improving students' critical thinking skills. Furthermore, students with higher levels of emotional intelligence tend to possess better critical thinking skills compared to those with lower emotional intelligence. This study also found an interaction between the PBL model and emotional intelligence, indicating that the combination of the two can optimally enhance students' critical thinking skills in the learning process.

17	Saparuddin, Sitti Aminah, & Ahdar	The Effectiveness of Problem Based Learning in Improving Critical Thinking and Emotional Intelligence of Students at SMK Negeri 3 Barru	The results of the study indicate that the implementation of the Problem Based Learning (PBL) model has a significant impact on improving students' critical thinking skills and emotional intelligence. Based on statistical analysis using the MANOVA test, it was found that both dependent variables increased simultaneously following the implementation of PBL. This indicates that PBL is not only effective in developing students' cognitive aspects but also contributes to the development of affective aspects, particularly in emotion regulation, collaboration, and students' social skills during the learning process.
18	Fadhilla Maharani, Arjudin, Dwi Novitasari, & Sri Subarinah	Pengembangan Lembar Kerja Peserta Didik Berbasis Problem Based Learning Berorientasi Kemampuan Berpikir Kritis Siswa SMK	The research results indicate that the development of Student Worksheets (LKPD) based on Problem Based Learning (PBL) is deemed suitable for use in the learning process and capable of supporting the improvement of students' critical thinking skills. The developed worksheets present contextual problems that encourage students to analyze, evaluate, and find solutions both independently and in groups. Furthermore, the use of PBL-based LKPDs also increases students' active engagement in learning and helps make the learning process more structured and student-centered.
19	Dedi Purnama	Meningkatkan Motivasi Berpikir Kritis Model PBL FASE F Materi Hierarki Gereja SMK Negeri 1 Tumbang Titi	Based on the research results, the implementation of the video-assisted PBL model increased students' learning motivation and critical thinking skills. This is evident from the increase in learning independence across all indicators and the rise in the number of students in the proficient category from 7 to 15 students in Cycle II.
20	Muhammad Faisal Kurniawan, Listyaningsih, & Totok Sujatmiko	Meningkatkan Kemampuan Berpikir Kritis Melalui Model Problem Based Learning Bermedia E-Modul Pada Peserta	The study indicates an improvement in students' critical thinking skills through the implementation of the Problem Based Learning (PBL) model supported by e-modules. Learning implementation improved from 66% in Cycle I to 84% in Cycle II. Improvements were also observed in critical

		Didik Smkn 2 Bojonegoro	thinking skill indicators, marked by a shift in categories from “adequate/below average” to “good” and “very good.” Student learning achievement rates increased from 39% to 66.7%, thereby confirming that the e-module-assisted PBL model is effective in enhancing students’ critical thinking skills and learning outcome
21	Alifia Rafa Aprilianti & Siswandari	Keefektifan Model Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMK Akuntansi pada Pembelajaran Komputer Akuntansi	The results indicate that the implementation of the Problem Based Learning (PBL) model is effective in enhancing the critical thinking skills of vocational high school accounting students in accounting computer studies. This is evidenced by an increase in the average score from 59.12 on the pre-test to 77.22 on the post-test, as well as improvements in the indicators of analytical, evaluative, and creative thinking skills. Statistical test results showed a significance level of 0.000 < 0.05, indicating that PBL has a significant effect on improving students’ critical thinking skills.
22	Marhaeni Dini, Isra Deviyanti, & Nasmiati Nasaruddin	Peningkatan Kemampuan Berpikir Kritis, Komunikasi, dan Kolaborasi melalui Penerapan Model PBL Berbantuan Multimedia pada Pembelajaran Bahasa Indonesia SMKN 2 Gowa	The classroom action research that was conducted showed an improvement in the implementation of learning, both in terms of teacher activities and student activities, throughout Cycle I and Cycle II. Teacher activity increased from 77.5% (fairly good) in Cycle I to 94.28% (good) in Cycle II, while student activity rose from 67.5% (fairly good) to 87.5% (good).
23	Yeyen Suryani, Melasari, Nanung Nurjannah, Iis Trisno Iskandar, Oyoh Rokayah, & Ibnu Udy Prasetyo	Penerapan Lesson Study Dengan Problem Based Learning Untuk Meningkatkan Kemampuan Berpikir Kritis	The research results indicate that the implementation of Lesson Study using the Problem Based Learning (PBL) model is effective in enhancing students’ critical thinking skills. Students demonstrated improvements in their willingness to express opinions, discussion skills, group collaboration, focus on problem-solving, and self-confidence when presenting discussion outcomes. Reflections during each learning cycle

			also helped teachers improve the quality of the learning process, thereby positively impacting students' critical thinking skills.
24	Selly Arafah Siregar & Munajat	Pengaruh Model Pembelajaran Problem Based Learning (PBL) Berbantuan Media Video Terhadap Kemampuan Berpikir Kritis Dan Hasil Belajar Siswa Kelas XI MPLB Pada Elemen Pembelajaran Pengelolaan Administrasi Umum SMK Negeri 1 Medan 2024/2025	The research results indicate a positive and significant effect of the video-assisted PBL model on critical thinking skills and learning outcomes. In the experimental class, the average critical thinking score increased from 59.43 to 83.31, while the average learning outcome score increased from 60.25 to 80.14. The results of the hypothesis test showed a Sig. value < 0.05, which means that the video-assisted PBL model is more effective than conventional methods in improving students' ability to analyze problems, evaluate information, and achieve learning mastery in the General Administration subject.
25	Mutiara Rahma Dewi, Susanti Kurniawati & Nofriansyah	Pengembangan Kemampuan Berpikir Kritis Siswa melalui Model Problem Based Learning (PBL) Dimoderasi oleh Kemampuan Metakognitif	The research results indicate that the implementation of the Problem Based Learning (PBL) model is significantly more effective in developing students' critical thinking skills compared to conventional learning. This is evident from the distribution of critical thinking skills in the experimental class, where a higher proportion of students fell into the moderate to high categories, while the control class remained dominated by the low to moderate categories. However, metacognitive ability was not found to act as a moderator variable that strengthens the influence of PBL on critical thinking skills. Thus, although PBL is effective in improving critical thinking skills, this effect is not significantly influenced by students' level of metacognitive ability.
26	Fahmi Amrullah, Tutik Susilowati, & Jumiyanto Widodo	Penerapan Problem Based Learning untuk meningkatkan kemampuan berpikir	The research results indicate that the implementation of the PBL model through five main stages problem orientation, student organization, guided inquiry, development and presentation of work products, and evaluation—is

		kritis siswa SMK Batik 2 Surakarta	capable of gradually enhancing students' critical thinking skills. Students became more skilled at identifying problems, analyzing information, and formulating solutions. This improvement was evident in students' learning outcomes, which improved with each cycle, particularly in the subject of Automation of Facilities and Infrastructure Management.
27	Vicky Vidyasary, Restu Lusiana, & Sri Wahyu Utami	Penerapan Model Problem Based Learning Berbasis Kontekstual untuk Meningkatkan Kemampuan Berpikir Kritis Siswa Kelas X	The research results indicate that the implementation of a contextual Problem Based Learning (PBL) model is capable of improving the overall quality of learning. Teachers' instructional activities improved in terms of classroom management and the presentation of contextual problems. Additionally, students' learning activities became more active, marked by increased participation in discussions and problem-solving. Students' critical thinking skills also showed significant improvement in each cycle, indicating that the contextual approach in PBL is effective in helping students connect the material to real-life situations.
28	Tasya Widya Sari & Lies Nurhaini	Pengaruh Model Problem Based Learning Berbantuan Mind Mapping terhadap Kemampuan Berpikir Kritis Siswa di SMK	Based on the results of the independent samples t-test, the significance level (2-tailed) was found to be < 0.001. This result meets the criteria for accepting the decision, namely a significance level (2-tailed) < 0.05, so the hypothesis is accepted. This means that in this study, there is a difference in the level of students' critical thinking skills between the experimental class and the control class, based on the analysis of the average posttest scores of both classes, namely 85.78 for the experimental class and 76.17 for the control class. These figures indicate that the experimental class demonstrated a critical thinking ability level 9.61 points higher than the control class following the implementation of the Problem Based Learning model assisted by mind mapping. Thus, indirectly, the

			implementation of the Problem Based Learning model assisted by mind mapping has an effect on improving students' critical thinking abilities in the tax administration subject at SMK XYZ.
29	Taufik Hidayat, Sucipto, & Sri Yuni Hanifah	Pengaruh Model Pembelajaran Problem Based Learning Terhadap Peningkatan Keterampilan Berpikir Kritis dan Kreatif Pelajaran Matematika	The results of the T-test analysis showed that the average creative thinking questionnaire score for the control class was 63.50 and for the experimental class was 81.39, while the Sig. (2-tailed) was 0.000 < 0.05, meaning H0 was rejected and H1 was accepted; this indicates that there is a significant difference in the average creative thinking scores between the control class and the experimental class.
30	Riqi Diana & Sutirman	Pengembangan Modul Pembelajaran PBL untuk Meningkatkan Kemampuan Berpikir Kritis Dan Kreatif Siswa SMK	The research results indicate that the development of a Problem Based Learning (PBL)-based learning module is deemed feasible and effective for use in the learning process. The developed module is capable of enhancing students' critical and creative thinking skills through the presentation of contextual problems that encourage analysis, idea exploration, and problem-solving. Additionally, the use of the PBL module also increases students' active engagement and helps them understand the material more deeply, thereby making learning more meaningful and student-centered.

Critical thinking is a skill that students must possess, particularly at the vocational high school (SMK) level. This skill encourages students to understand the problems they face so that they can determine solutions logically and systematically. According to Facione (2023), critical thinking is a cognitive process that involves interpretation, analysis, evaluation, and inference. With this ability, students can view a problem from various perspectives, resulting in more appropriate solutions.

Critical thinking skills are closely linked to student learning outcomes. Learning outcomes serve as indicators of student achievement in the learning process. Based on the research findings of Hadi Hasan et al. (2023), the implementation of a Problem Based Learning (PBL) model can enhance critical thinking skills, which in turn leads to improved

student learning outcomes. This aligns with the research by Dedi Purnama et al. (2023), which states that the PBL model can enhance students' motivation and critical thinking skills.

Based on the analysis of the journal articles reviewed, student learning outcomes are generally measured using pretests and posttests. These articles indicate that there is an improvement in learning outcomes following the implementation of PBL. This is supported by the research by Faisal Kurniawan et al. (2023), which demonstrates that the implementation of PBL significantly enhances students' critical thinking skills. An effective learning process is heavily influenced by the teacher's ability to manage the learning process. According to Rahardjanto et al. (2019), the success of learning is determined by the strategies used by teachers. This is reinforced by the research of Amrullah et al. (2024), which states that the implementation of the PBL model can increase student activity and engagement in learning.

The Problem Based Learning (PBL) model is a student-centered learning model that uses problems as the basis for learning. According to Barrows (2023), PBL encourages students to be active in the learning process through problem-solving. This is supported by research by Widya Sari et al. (2024), which shows that the implementation of PBL has a positive effect on students' critical thinking skills. The goal of Problem Based Learning is for students to be able to understand concepts deeply and relate them to real life. This is supported by research by Winda (2024), which states that the use of PBL supported by learning media can improve students' conceptual understanding and critical thinking skills. The implementation of PBL demonstrates that students' critical thinking skills develop through active engagement in the process of solving real-world problems. Activities such as analysis, discussion, and decision-making help students build a deeper and more meaningful understanding.

The PBL model involves several stages in its implementation. According to Sani (2015), these stages include problem presentation, student organization, investigation, presentation of results, and evaluation. Based on the analysis of the article, each of these stages contributes to enhancing students' critical thinking skills. During the problem presentation stage, students are presented with relevant problems. This is supported by Maharani's (2023) research, which shows that the use of PBL-based media can improve students' critical thinking skills. The student organization stage is carried out through

group work. Based on research by Situmorang et al. (2025), group work in PBL can increase students' engagement and critical thinking skills. The investigation stage is the most important stage. Based on research by Kharisma et al. (2025), students who are actively involved in the investigation process demonstrate a significant improvement in critical thinking skills. The presentation of results stage is conducted through presentations. This is supported by research by Ana Latifah et al. (2025), which shows that presentation activities in PBL can improve students' communication and critical thinking skills. The evaluation and reflection stage is conducted to assess the learning process. Based on Safitri's (2026) research, reflection activities can increase students' awareness of the thinking processes they engage in. Based on the analysis of various research findings, each stage in PBL is interrelated in shaping students' critical thinking skills. Problem presentation trains analytical skills, the investigation process helps students evaluate information, while presentations and reflection strengthen argumentation skills and the ability to draw logical conclusions.

The implementation of the Problem Based Learning (PBL) model has a positive impact on the critical thinking skills of vocational high school students. Research by Rohmad (2024) shows that PBL can improve students' critical thinking skills and teamwork. Additionally, research by Diana (2025) and Dewi (2025) indicates that PBL can also significantly improve student learning outcomes. This is reinforced by research by Nur et al. (2024), which states that PBL can increase student engagement in learning. Another study by Fatimah Alindri et al. (2025) shows that integrating PBL into learning can comprehensively improve students' critical thinking skills. Furthermore, research by Regina et al. (2024) also indicates that PBL is effective in enhancing student learning activities. However, there are several challenges in implementing PBL. According to research by Sulistyani et al. (2024), although most studies show positive results, the effectiveness of PBL can vary across different classes and subjects. These differences are influenced by teacher readiness, students' prior knowledge, and classroom management. Consequently, the success of PBL also depends on the conditions of its implementation in practice.

Based on the overall analysis of the 30 journal articles reviewed, it can be concluded that the Problem Based Learning model is an effective approach for enhancing vocational high school students' critical thinking skills. This model provides meaningful learning

experiences through students' active engagement in the learning process. Observations revealed that students were more enthusiastic about learning because they felt challenged in solving problems relevant to their daily lives compared to simply listening to the teacher's explanations. However, there were still students who were less active and less engaged in discussions. In the learning process, student grouping will be adjusted based on observations made during discussions. The Problem Based Learning (PBL) model has been proven to have a significant positive impact on the critical thinking skills of vocational high school students. Through the stages of problem presentation, organization, investigation, presentation of results, and evaluation and reflection, PBL encourages students to think actively, logically, and systematically when solving real-world problems. Thus, the PBL model is worthy of continued development and widespread implementation at the vocational high school level as an effort to improve the quality of learning and prepare students to face challenges in the real world.

CONCLUSION

This study concludes that the implementation of Problem Based Learning in vocational high school education under the Merdeka Curriculum effectively enhances students' critical thinking skills based on various indicators and promotes active participation, collaboration, and learning outcomes. This effectiveness is also linked to the stages of PBL, which facilitate systematic processes of analysis, evaluation, and problem-solving. Scientifically, this effectiveness is supported by the characteristics of PBL, which positions real-world problems as triggers for higher-order cognitive processes. The contribution of this study lies in a comprehensive synthesis across studies that strengthens the position of PBL in vocational education. Theoretically, this study reinforces research on the effectiveness of Problem Based Learning in enhancing the critical thinking skills of vocational high school students in Merdeka Curriculum-based learning. These findings have implications for the development of Problem Based Learning strategies in vocational high schools. Practically, the results of this study can serve as a reference for teachers in designing more active, contextual, and student-centered learning. Additionally, these results can support the strengthening of the implementation of the Merdeka Curriculum through the application of Problem Based Learning models in vocational high schools. Therefore, teachers and schools are advised to improve instructional readiness, time

management, and the use of supporting media to ensure the implementation of PBL runs more optimally. However, this study has limitations regarding the number and scope of the articles analyzed, so it does not fully represent the entire learning context in vocational high schools. Furthermore, this research only employed a literature review approach without direct field testing. Consequently, the research results are highly dependent on the quality of the sources used and may introduce bias in the selection of references. Therefore, future research is advised to employ more systematic methods, such as meta-analysis which statistically combines and analyzes results from various studies or the PRISMA approach, which ensures the literature review process is conducted in a structured and transparent manner, to yield more comprehensive and in-depth findings.

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