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Critical Reasoning Skills of Vocational High School Students with Problem Based Learning Model: A Systematic Literature Review

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Abstract: A learning approach that has been extensively researched and proven effective in improving critical thinking skills is problem-based learning, or PBL. This learning model focuses on real-world problems. It encourages students to actively engage in the process of identifying, assessing, and developing collaborative solutions. Critical reasoning skills are essential for students to support independent thinking and problem-solving. The purpose of this study was to determine the critical reasoning skills of vocational high school students using the Problem Based Learning (PBL) model. The method used was a Systematic Literature Review (SLR). The articles used were sourced from Google Scholar and Crossref with the help of the Publish or Perish (PoP) application with a period of 2020-2025. All articles were sorted according to established criteria and had themes relevant to critical reasoning and problem-based learning, then collected a total of 17 articles. The results showed that the application of critical reasoning encouraged students to analyze, evaluate, and draw conclusions based on evidence, while PBL provided a real context for solving problems, developing problem-solving skills, and collaboration. Factors such as learning models, learning motivation, and learning environment influenced the critical reasoning of vocational high school students. These findings provide a deeper understanding of the application of the problem-based learning (PBL) model in improving critical reasoning of vocational high school students.

Keywords: Critical reasoning; Problem based learning; Systematic literature review; Vocational high school

Introduction

Critical reasoning is one of the higher-order thinking skills that students must possess to face the changes in 21st-century education. This is especially important for vocational high school (SMK) students who are being trained to directly face problems in the workplace. Students with critical thinking skills are able to evaluate arguments, examine data, and solve challenging problems responsibly and rationally. Vocational schools must now emphasize reflective thinking skills and how to apply them to solve real-world problems in business and everyday life, in addition to procedural knowledge (Saiz & Rivas, 2023). The implementation of the Problem-Based Learning (PBL) model in vocational schools has significantly improved students' critical thinking skills. Research conducted by Suryanti et al. (2023), developed a PBL worksheet for workshop engineering lessons. These findings indicate that students' critical thinking skills have significantly improved. Similar findings were also published by Syahraini et al. (2022), who found that implementing the PBL model simultaneously improved students' critical thinking skills and activity levels.

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According to Styaningrum et al. (2021), by exploring contextual issues, the PBL paradigm can help students strengthen their logical and methodical thinking skills.

Although critical thinking skills are essential for students to identify problems, analyze, and evaluate information, many students still struggle to develop these skills optimally, resulting in relatively low levels of critical reasoning skills. This is due to monotonous learning, resulting in a lack of student attention to the learning material (Jultiram, 2025). Students can become passive learners if they only pay attention to the teacher. They are not encouraged to investigate problems or develop a deeper understanding (Zahro et al., 2024; Goldberg et al., 2021; Van Leeuwen et al., 2019). Furthermore, research from Purnastiti (2024), shows that children experience difficulties in critical thinking. This is due to a lack of analytical skills, an inability to provide answers that meet expectations, or sometimes even no answers at all (Darwin et al., 2024). In fact, critical thinking skills are crucial for analyzing problems, making informed decisions, and collaborating effectively. This issue requires the implementation of more relevant, challenging, and student-focused learning strategies to foster critical thinking skills (Wardani & Fiorintina, 2023; Rittmann & Mpofu, 2024).

A learning approach that has been extensively researched and proven successful in improving critical thinking skills is problem-based learning, or PBL (Nicholus et al., 2024; Mutiara et al., 2024). This learning model focuses on real-world problems. It encourages students to actively engage in the process of identifying, evaluating, and developing collaborative solutions. According to Fedi et al. (2019) and Khafah et al. (2023), the PBL model has improved students' critical thinking skills. This occurs when tasks are aimed at motivating children to consider an issue from multiple perspectives when addressing a problem. Nuzula et al. (2023) and Dwiningsih et al. (2024), reported that STEM-based PBL has improved students' critical thinking skills because it is a systematic scientific reasoning process for solving problems while achieving physics learning outcomes.

The integration of the Problem-Based Learning (PBL) methodology and STEM concepts into mathematics learning materials resulted in significant improvements in students' critical thinking skills in vocational high schools (Nuzula et al., 2023; Yani et al., 2024). These findings support the notion that PBL is an appropriate and adaptable way to provide vocational high school students with the critical thinking skills they need to navigate today's complex workplace, social, and professional challenges. This study aims to clarify the importance of critical reasoning skills in the learning process in vocational high schools and demonstrates that the use of the Problem-Based Learning (PBL) model significantly helps students improve their critical reasoning skills, impacting their academic achievement.

Method

This study uses a systematic literature review (SLR) model as its research method. A systematic literature review (SLR) collects and analyzes data from scientific publications. In the composition of this work, an organized writing method that follows several stages of a systematic review consists of planning a strategy for searching for data and information sources, research reduction based on quality assessment with eligibility criteria, and data synthesis and analysis. The systematic literature review (SLR) research procedure design used in this study is presented in Figure 1.

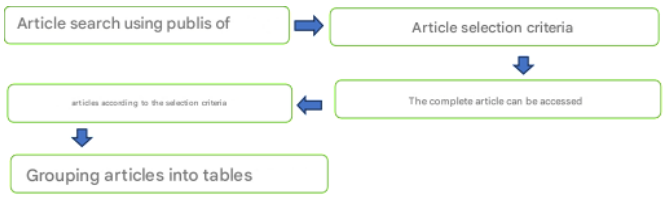

Figure 1. Systematic literature review stages

Article Search

The article search in this study included firstly searching for information sources. The information sources used in this search were Google Scholar and Crossef, with the help of Publish or Perish (PoP) software. The search was based on the title "Critical Reasoning Skills of Vocational High School Students" and the keyword "Problem-Based Learning." The next stage was the eligibility criteria. The eligibility criteria in this study used exclusion and inclusion criteria.

Article Selection Criteria

The article selection criteria used in this study are shown in Table 1.

Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria (Accepted Articles)	Exclusion Criteria (Articles Rejected)
Articles must discuss reasoning/critical thinking skills in the application of PBL in educational contexts.	Articles discussing critical thinking skills not using the PBL model
Articles must be published between 2020 and 2025.	Articles discussing the PBL model and critical thinking skills at the elementary and middle school levels
icles must be written in Indonesian.	Articles using English
icles must be open access and fully accessible.	

Article Reduction According to Selection Criteria

Articles were searched from Google Scholar and Crossref databases using Publish or Perish software, resulting in 1,200 articles. The search was based on the title "Critical Reasoning Skills of Vocational High School Students" and the keyword "Problem-Based Learning." A reduction process then resulted in 300 articles meeting the criteria, while 900 articles did not meet the specified criteria. Articles meeting the inclusion criteria were further screened through reduction to ensure their suitability to the focus of this study. The reduction of 300 articles consisted of 180 articles discussing critical thinking skills not using the PBL model, 90 articles discussing the PBL model and critical thinking skills at the elementary and junior high school levels, and 13 articles using English. A final screening process for inclusion resulted in 17 articles meeting the established criteria as research data. A total of 17 articles were reviewed and selected as research data. The review was conducted carefully to ensure that each article met the established inclusion criteria and was relevant to the research focus. The article filtering scheme is presented in Figure 2.

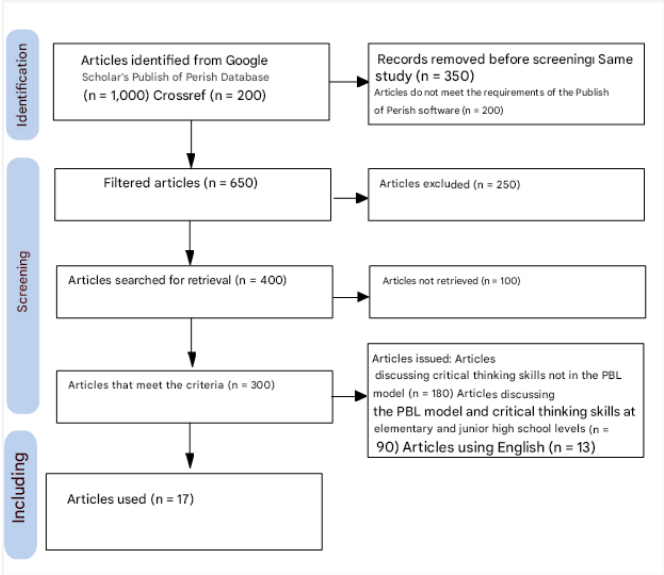

Figure 2. FRISMA diagram

Based on the article selection results presented in Figure 2, 17 articles were selected as eligible and will proceed to the analysis stage. The data analysis stage consists of a table containing the author's name, year of publication, research method, and research title.

Table 2. Article Data

Author Name	Year	Method	Research Title Name
Hasan, H., & Nindiasari, H	2023	Quantitative	Efektivitas problem based learning (PBL) untuk meningkatkan kemampuan berpikir kritis siswa di SMK Negeri 2 Pandeglang
Rachmawati, N. Y., & Rosy, B.	2021	Quasi-Experimental Design	Pengaruh model pembelajaran problem based learning (PBL) terhadap kemampuan berpikir kritis dan pemecahan masalah pada mata pelajaran administrasi umum kelas X OTKP di SMK Negeri 10 Surabaya
Aprilianti, A. R., & Siswandari, S	2024	Quasi-Experimental	Keefektifan Model Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMK Akuntansi pada Pembelajaran Komputer Akuntansi
Agustina, P. R., & Joyoatmojo, S.	2024	Classroom Action Research	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
Ariyanto, S. R., Lestari, I. W. P., Hasanah, S. U., Rahmah, L., & Purwanto, D. V.	2020	Qualitative	Problem based learning dan argumentation sebagai solusi dalam meningkatkan kemampuan berpikir kritis siswa SMK
Pebriyani, E.P & Pahlevi, T	2020	Experimental	Pengaruh Model Pembelajaran Problem Based Learning (PBL) Terhadap Kemampuan Berpikir Kritis dan Hasil Belajar Peserta Didik Pada Mata Pelajaran Kearsipan Kelas X OTKP Di SMK Negeri 1 Sooko Mojokerto
Suryani, Y., Melasari, M., Nurjannah, N., Iskandar, I. T., Rokayah, O., Prasetyo, I. U., & Hidayanti, N. F.	2023	Quantitative	Penerapan lesson study dengan problem based learning untuk meningkatkan kemampuan berpikir kritis
Fakhri, M. M., Al Ihlas, M., Suwahyu, I., Rahman, A., & Muthmainnah, S	2022	Quantitative	Pengaruh Problem Based Learning Terhadap Keterampilan Berpikir Kritis Peserta Didik SMK Negeri 2 Makassar
Permatasari, B. W. P., & Muchsini, B	2024	Quasi-Experimental	Pengaruh PBL Berbantuan Quizizz Dalam Pembelajaran PJDM Terhadap Kemampuan Berpikir Kritis Siswa SMK

Author Name	Year	Method	Research Title Name
Sari, D. P	2021	Classroom Action Research	Pengaruh Pendekatan Problem Based Learning (PBL) terhadap Kemampuan Berpikir Kreatif Matematis Siswa Kelas X SMK Putra Anda Binjai
Nurjanah, Y., & Sawiji, H.	2025	Classroom Action Research	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
Mandagi, F. A., Paloboran, M., & Sudirman, S.	2021	Classroom Action Research	Peningkatan Keterampilan Berpikir Kritis Dan Hasil Belajar Melalui Penerapan Model Problem Based Learning
Kartika, I. M., Mahendra, P. R. A., & Awa, V.	2020	Classroom Action Research	Penerapan pembelajaran problem based learning untuk meningkatkan ketrampilan berpikir kritis siswa pada mata pelajaran PPKn
Khasanah, D. M	2023	Quantitative	Upaya Meningkatkan Kemampuan Berpikir Kritis Peserta Didik pada Mata Pelajaran Produktif Pemasaran Kelas XI Pemasaran 2 SMK Negeri 1 Karanganyar
Fitri, H., Supriyoko, S., & Prihatni, Y	2021	Classroom Action Research	Pengembangan Instrumen Pengukuran Sikap Bernalar Kritis Pada Siswa SMK Pembaharuan di Purworejo
Zarmin, L.	2022	Quasi-Experimental	Peningkatan kemampuan berpikir kritis dan nilai-nilai kearifan lokal melalui penerapan model problem based learning dalam pembelajaran sejarah siswa kelas x. 1 teknik audio video smk negeri 2 baubau semester ganjil tahun pelajaran 2019/2020
Sari, T. W., & Nurhaini, L.	2024	Quantitative	Pengaruh Model Problem Based Learning Berbantuan Mind Mapping Terhadap Kemampuan Berpikir Kritis Siswa di SMK

Result and Discussion

The analysis results of 17 articles that met the inclusion criteria are presented in a table to highlight the critical reasoning skills of vocational high school students using the problem-based learning model.

Results, Themes, and Objectives

Based on the analysis of the 17 articles presented in Table 2 above, it was found that the critical reasoning skills of vocational high school students using the Problem-Based Learning model were implemented with several objectives. Most of the studies aimed to improve students' reasoning thinking skills using the PBL learning model. Two studies also aimed to improve critical thinking skills using other learning models. The percentage of objectives and themes is presented in Table 3.

Based on the analysis and synthesis of 17 articles, the majority of studies found that the problem-based learning (PBL) model improved critical reasoning skills. This fact indicates that the Problem-Based Learning (PBL) model is highly effective in improving students' critical reasoning skills. This finding aligns with research conducted by (Kuntum Br Sinuhaji, 2023), which showed that implementing video-assisted PBL can improve student independence, critical thinking skills, and learning outcomes. Furthermore, two studies demonstrated improvements in critical thinking skills with other models. The findings of this study are presented in Table 4.

Table 3. Research Objectives

Research Objectives	Percentage (%)
To improve students' reasoning/critical thinking skills with PBL	88
To improve critical thinking levels using other learning models.	12

Table 4. Research Findings

Learning model	Test Score Results	Author Name, Year
Problem Based Learning (PBL)	Students' critical thinking skills increased from an average pre-test score of 66.00 to an average post-test score of 83.4722 in mathematics.	(Hasan & Nindiasari, 2023)
Problem Based Learning (PBL)	The average critical thinking score in the experimental class was 76.93, while in the control class it was 65.67. This indicates a significant influence between the experimental and control classes.	(Rachmawati & Rosy, 2020)

Learning model	Test Score Results	Author Name, Year
Problem Based Learning (PBL)	Students' critical thinking skills averaged 59.12 before the pre-test, while after the post-test, the average increased to 77.22.6%.	(Aprilianti & Siswandari, 2024)
Problem Based Learning (PBL)	There was a significant increase from the pre-test to the second cycle, and in the second cycle, the research success target of 77.14% was achieved.	
Problem Based Learning (PBL)	This study demonstrates that the implementation of Problem-Based Learning and Argumentation (PBLA) has the potential to provide benefits for vocational high school students, such as increased experience, motivation, innovation, and 21st-century skills.	(Ariyanto et al., 2020)
Problem Based Learning (PBL)	This study shows that the average critical thinking ability score in the experimental class was 83, while the control class was 72. Regarding learning outcomes, the average pretest-posttest score in the experimental class increased from 57.35 to 85.29, representing a 27.94-point increase, while the control class increased from 52.21 to 74.85, representing a 22.64-point increase.	(Pebriyani & Pahlevi, 2020)
Problem Based Learning (PBL)	This study demonstrates that the implementation of the Problem-Based Learning (PBL) learning model through lesson study can improve students' critical thinking skills and scientific attitudes.	(Suryani et al., 2023)
Problem Based Learning (PBL)	This study demonstrates that the Problem-Based Learning model effectively contributes 32.6% to improving students' critical thinking skills. Furthermore, the calculated t-value was greater than the calculated t-value, indicating a significant effect of the model on students' critical thinking skills.	(Fakhri et al., 2022)
Problem Based Learning (PBL)	This indicates that the average posttest score for the experimental group was 83.19, while for the control group it was 62.64. Furthermore, the N-Gain test results showed an average N-Gain score for the experimental class of 0.48 (moderate category), while the control class had a score of 0.04 (low category).	(Permatasari et al.., 2024)
Problem Based Learning (PBL)	The average score for the experimental class (using PBL) was higher, at 60.00, compared to the control class's 51.00. This is supported by the t-test results, with the calculated t-value > t-value (1.906 > 1.671), thus accepting the hypothesis and confirming that the PBL approach positively influenced students' mathematical creative thinking skills.	(Suherman et al., 2020)
Problem Based Learning (PBL)	This indicates that the implementation of the Problem-Based Learning (PBL) model can improve students' critical thinking skills. The percentage of students achieving the Minimum Completion Criteria (KKM) increased from 32.25% in the first meeting of Cycle I to 77.41% in the second meeting of Cycle II.	(Setyawan & Koeswanti, 2021)
Problem Based Learning (PBL)	Specifically, students' critical thinking skills improved, with 71.69% achieving a very high score, and their learning outcomes increased by 33.97%, with 100% achieving the Minimum Completion Standard (SKM).	(Mandagi et al., 2021)
Problem Based Learning (PBL)	The scores in this study showed an increase from Cycle I to Cycle II. In Cycle I, the average student cognitive score was 79, with a classical completion rate of 71%. Meanwhile, in Cycle II, the average score increased to 84, with classical completion reaching 100%.	(Kartika et al., 2020)
Team Games Tournament (TGT)	Students' critical thinking skills increased from 0% in the pre-cycle to 79.5% in Cycle I and 77.1% in Cycle II.	(Khasanah, 2023)
Development	Overall, students' critical reasoning skills at SMK Pembaharuan in Purworejo were in the good and very good categories, at 60.07%.	(Fitri et al., 2021)
Problem Based Learning (PBL)	Through three learning cycles, significant improvements occurred in both aspects, with students' critical thinking skills	(Zarmin, 2022)

Learning model	Test Score Results	Author Name, Year
	increasing from 74.07% to 96.15%, and their local wisdom scores increasing from 96.30% to 100%.	
Problem Based Learning (PBL)	The post-test scores for the experimental class were higher with a significance level of <0.001, thus supporting the hypothesis that the implementation of PBL assisted by mind mapping has an impact on students' critical thinking skills.	(Sari & Nurhaini, 2024)

Critical Reasoning Skills in Learning

Based on the research study summarized in the findings table, it can be concluded that critical reasoning skills in learning are a fundamental aspect that cannot be ignored, especially in the context of learning (Yani et al., 2024), define critical reasoning as an important skill taught, encouraged, and developed in schools so that students can effectively, skillfully, critically, responsibly, and rationally reach valid conclusions to address problems in their environment. Critical thinking skills are a person's ability to analyze and evaluate information from their observations rationally to build a foundation of self-confidence for making decisions or solving problems. Critical thinking skills include analyzing information, evaluating arguments, and rationally generating solutions to improve existing solutions. They are able to connect various types of information, analyze data, evaluate results, and draw conclusions based on their findings (Lashmi et al., 2023). Students with critical thinking skills are able to assess qualitative and quantitative information objectively. This process requires students to interpret and evaluate opinions to reach a conclusion about the existence of a new perspective/view (Hugo, 2023).

Indicators used to measure the level of students' critical thinking skills consist of identifying problems (focus), identifying real problems and accompanying evidence (reason), providing appropriate solutions to emerging problems (inference), understanding students' state of mind (situation), providing evidence for solutions to emerging problems (clarity), and re-examining the appropriate steps in providing a solution to the problem (overview) (Danissih et al., 2024). Therefore, critical thinking skills not only function for academic purposes but are also needed in everyday life. When education prepares students to become capable critical thinkers and adaptive individuals, education plays a crucial role. Furthermore, the development of critical thinking skills may have implications that can have a broad impact in the future. Critical thinking skills are very important when students face dilemmas and solve problems (Achmad et al., 2023).

Implementing the Problem-Based Learning Model

The application of the Problem-Based Learning (PBL) model in student learning aims to hone their critical thinking skills through context-relevant learning experiences. According to Gunawan et al. (2023), implementing the PBL model in a classroom at an educational institution has proven highly effective in improving or influencing students' critical thinking skills. The learning model used in. PBL is a problem-focused approach. In this model, students are faced with a problem to solve. The goal of this approach is to help students make decisions based on problem-solving and to help them develop critical thinking to acquire new knowledge, thus encouraging them to gather information to solve problems (Mardiyanti, 2020). Furthermore, according to Ayunda et al. (2023), the Problem-Based Learning (PBL) model is a context-focused learning approach. In this method, a problem serves as the core of learning activities.

The PBL model is one approach that can improve students' critical thinking skills in complex situations. With this method, students are expected to play an active role in the learning process. A study conducted by (Hastawan et al., 2023), revealed that implementing the Problem-Based Learning (PBL) model offers several benefits, including increasing student engagement in the learning process and fostering cooperation, tolerance, discipline, and self-confidence. Furthermore, research by Maharani et al. (2023), shows that the PBL model encourages students to acquire knowledge and skills through their own exploration in solving problems encountered in everyday life.

Effectiveness of Problem-Based Learning on Critical Thinking Skills

Based on the analysis of 17 articles presented in Table 4, the Problem-Based Learning (PBL) model has proven to be an effective learning approach in developing students' critical thinking skills. PBL emphasizes student-centered learning by solving real-world, complex problems as a backdrop for learning, thinking, and collaboration. According to Putri (2025), the use of PBL not only helps students understand the material in depth but also provides them with opportunities to analyze, express, and formulate arguments in an organized manner. A significant positive relationship between the application of the PBL method and improving students' critical thinking skills in the learning environment. The effectiveness of PBL is more evident when combined with learning tools, such as student worksheets (LKPD) and digital technology.

According to Louto et al. (2025), the use of LKPD in Problem-Based Learning (PBL) can encourage students to be more independent in identifying problems, seeking information, and designing evidence-based solutions. The use of audiovisual media in PBL has been shown to improve the quality of the learning experience.

A research study Ningtias et al. (2024), explains that such media facilitates students' clearer understanding of the problem context, thereby enhancing the effectiveness of critical thinking processes. Videos used in project-based learning can significantly improve students' critical thinking skills, particularly those related to global warming. Contextual elements in Problem-Based Learning (PBL) also play a crucial role in enhancing critical thinking skills. According to Hardianty et al. (2021), the application of a PBL approach that focuses on socio-scientific issues can increase student engagement in relevant scientific and social topics. This encourages them to think reflectively and ethically. PBL-based education to achieve sustainability in development. They found that students learned to think critically about various issues, but also felt a sense of social responsibility regarding environmental issues.

Curating local values through the integration of PBL with ethnoscience reportedly further emphasized the relationship between science and local culture, and specifically improved students' critical thinking skills. Furthermore, the effectiveness of PBL is also evident in improved learning outcomes, which align with the development of critical thinking skills. Research The PBL model using Moodle not only improves student learning outcomes but also gradually supports them in developing critical thinking skills. The PBL model can train students to think critically in a systematic and structured manner by discussing and exploring real-world problems. Implementation of PBL has a positive effect on learning independence and critical thinking skills simultaneously.

The implementation of PBL across various subjects and educational levels has demonstrated success in improving students' critical thinking skills. The application of the Problem Based Learning (PBL) model in Natural Sciences (IPA) subjects has a significant influence on improving students' critical thinking skills, Context of learning Natural Sciences in Madrasah Ibtidaiyah, PBL can improve critical thinking skills starting from the basic level. In addition, PBL model allows students to open their minds, analyze existing information, and consider other possible solutions. From the results of several studies, it can be concluded that PBL is a very effective learning model in developing students' critical thinking skills in a meaningful, contextual, and sustainable manner.

Conclusion

Critical reasoning is an essential skill that needs to be developed throughout the learning process. Critical thinking enables one to critically analyze information, evaluate arguments, and solve problems logically. The Problem-Based Learning (PBL) model enhances critical thinking skills by exposing students to real-world problems. This approach encourages students to think actively, independently, and reflectively. PBL can be combined with student worksheets (LKPD), digital tools, and social and cultural contexts to enhance critical thinking skills. Numerous studies have shown that Problem-Based Learning (PBL) not only improves academic achievement but also helps develop students' character. With PBL, students become more able to think systematically, be open to new ideas, and take responsibility when facing challenges in everyday life.

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Author Contributions
Conducted research, H.; resources, H.; writing, H; conducted review and editing of the manuscript, I.N.T.; I.B.P.A., and I.W.R. All authors have read and approved the final version of the manuscript published.

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Conflicts of Interest
The authors declare no conflict of interest.

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