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THE EFFECTIVENESS OF PROBLEM-BASED LEARNING (PBL) IN CHEMISTRY ON STUDENTS' CRITICAL THINKING SKILLS: A LITERATURE REVIEW ON ITS IMPLEMENTATION IN INDONESIAN HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

Critical thinking skills are a fundamental competence required of students in the 21st century, particularly in the study of chemistry, which is abstract in nature and requires a deep conceptual understanding. This study aims to analyse the effectiveness of Problem-Based Learning (PBL)-based chemistry education on students' critical thinking skills at Indonesian universities through a systematic literature review. The results indicate that PBL has been proven to be effective in enhancing students' critical thinking skills, with an average N-Gain score of 0.71 in the high category and a 31 per cent increase in cognitive learning outcomes. The PBL framework, comprising five stages (problem orientation, learning organisation, individual and group investigation, presentation of results, and process evaluation), provides a systematic learning structure to develop the six indicators of critical thinking according to Facione, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation. The implementation of PBL in Indonesian higher education institutions faces challenges such as limited learning time, a heavy curriculum load, variations in lecturers' competence, and a lack of supporting facilities. However, PBL still offers advantages in making chemistry learning more contextual, encouraging independent learning, and developing collaborative skills and problem-solving in real-world situations. This study recommends the development of more valid PBL-integrated chemistry teaching materials, the integration of digital technology into PBL implementation, and the need for lecturer training to optimise their role as facilitators in PBL-based chemistry learning.

Keywords: Problem-Based Learning, chemistry learning, critical thinking, students, higher education, literature review

Introduction

Higher education in the 21st century demands the implementation of learning models capable of enhancing students' critical thinking, problem-solving and independent learning skills. Critical thinking is one of the fundamental competencies required to tackle increasingly complex global challenges (Zeichner, 2010) . In the context of chemistry learning at university level, this ability is particularly important because chemistry is an abstract science that requires a deep conceptual understanding to be applied in real life(Redhana, 2019) . However, empirical evidence shows that many students still struggle to understand chemical concepts and develop their critical thinking skills.

Conventional chemistry teaching, which remains the dominant approach in Indonesian universities, tends to employ a teacher-centred approach involving lectures and passive learning. This approach results in students being less active in the learning process and acting merely as recipients of information (Lewis & Gilman, 2005) . Consequently, students achieve poor learning outcomes and struggle to solve problems in various areas of chemistry, such as stoichiometry, chemical equilibrium, redox reactions, acids and bases, and salt hydrolysis. Students' learning outcomes, which typically fall below the minimum proficiency criteria, are significantly influenced by these issues inherent in conventional teaching methods (Redhana, 2019) . The limitations of conventional learning are increasingly apparent in the context of the digital age, which demands the integration of technology and the development of 21st-century skills. Problem-solving, critical thinking, communication, collaboration and creativity are skills that are vital for the nation's younger generation to master(Wicaksono, 2021) . Students need to possess the ability to think actively, communicate, process data and draw scientific conclusions. However, numerous studies indicate that the use of digital technology in chemistry teaching has not yet been fully accompanied by the implementation of effective teaching models designed to enhance students' problem-solving and critical thinking skills(Subagia, 2014) .

Problem-Based Learning (PBL) has emerged as a relevant alternative learning model to address these issues. PBL is a learning model in which students are engaged in attempting to solve problems by following several stages of the scientific method; it is hoped that students will thereby acquire knowledge relevant to the problem at hand whilst simultaneously developing problem-solving skills. This model was first developed by Barrows and Tamblyn in the 1980s at the Faculty of Medicine, McMaster University, Canada, and has proven effective in problem-solving-focused learning through case studies (San et al., 2020) .

According to Howard Barrows, the syntax of Problem-Based Learning consists of five main steps: (1) orienting students to the problem, (2) organising students, (3) guiding individual and group investigations, (4) developing and presenting results, and (5) analysing and evaluating the process to assess problem-solving outcomes (Aslan & Imelda, 2025) . In PBL, students actively construct their knowledge from the beginning to the end of the learning process. By presenting real-world problems, problem-based learning makes the learning process more meaningful and contextual(Widiastuti et al., 2018) . Students are required to search for, analyse and evaluate information, make decisions, and solve problems both independently and collaboratively.

According to Facione, critical thinking is purposeful thinking, such as proving a point, interpreting the meaning of something, or solving a problem. Facione states that there are six key indicators of critical thinking skills involved in the critical thinking process, namely interpretation, analysis, evaluation, inference, explanation and self-regulation(Facione, 2011) . Meanwhile, according to Ennis, the indicators of critical thinking are divided into five categories: providing a simple explanation, building basic skills, drawing conclusions, providing further explanations, and devising strategies and tactics, which are contained within 12 sub-indicators (Ennis, 2015) . Both definitions demonstrate that critical thinking is a complex and structured cognitive process.

In chemistry education, chemical literacy and critical thinking are essential for both lecturers and students to understand broad and abstract concepts. Lecturers must encourage students to think critically and develop the ability to apply chemical concepts to real-life situations. Indicators of chemical literacy encompass four main aspects: knowledge of chemical material and scientific ideas, chemistry in context, higher-order learning skills, and effectiveness. Meanwhile, according to Ennis, indicators of critical thinking include providing basic explanations, building basic skills, drawing conclusions, offering further explanations, and devising strategies and tactics (Ennis, 2015) .

The implementation of the PBL model has been shown to have an impact on students' chemical literacy and critical thinking skills. A quasi-experimental study using a non-equivalent control group design revealed a significant difference between students taught using the PBL model and those not taught using this model. The implementation of the PBL model has been shown to have an effect on students' chemical literacy and critical thinking skills, with a significance value of 0.000, which is less than 0.05 (Rahmawati et al., 2025) . It can therefore be concluded that the implementation of PBL can significantly improve students' chemical literacy and critical thinking skills compared to teaching methods that do not use this model.

The advantages of the PBL model in chemistry teaching encompass five key aspects. Firstly, students are encouraged to develop problem-solving skills in real-life situations. Secondly, students acquire the skills to construct their own knowledge through learning activities. Thirdly, learning is problem-centred, meaning that students do not need to study unrelated material. Fourthly, scientific activities take place through group work. Fifthly, students become accustomed to using knowledge sources from libraries, the internet, interviews and observation (Pawar et al., 2020) . PBL helps students to better connect what they have learnt with real-world problems, thereby helping them to retain information more effectively (Hamari et al., 2016) .

The implementation of PBL in chemistry teaching requires integration with appropriate learning resources to optimise learning outcomes. The use of the PhET virtual laboratory can enhance students' critical thinking skills, as PhET helps students to understand abstract concepts more easily in concrete terms(& Aslan, 2024) . PhET presents molecular shapes, molecular colours and chemical symbols at a microscopic level, making it easier for students to organise and retain information. PhET features visual displays and interactions between students and the concepts being taught, which help to develop their understanding (Elmiwati & Aslan, 2025) .

Although PBL has proven to be effective, its implementation in Indonesian higher education institutions still faces various challenges. Limited teaching time, a heavy curriculum workload, variations in lecturers' competencies, and a lack of supporting facilities are the main obstacles. Lecturers who lack a thorough understanding of the learning model to be implemented are unable to develop effective learning models to develop students' skills and, ultimately, cannot make a significant contribution to the achievement of students' learning outcomes(Busnawir & Aslan, 2026) . Therefore, strategies are required to optimise the implementation of PBL, tailored to the context and learning material.

Consequently, this study is important in order to gain a comprehensive overview of research trends, the strengths of the findings, and the limitations of the PBL model in chemistry education at Indonesian universities. This systematic review is vital for strengthening the foundation for the implementation of the PBL model and providing practical benefits for educators in designing chemistry teaching that is in line with technological advances and 21st-century skills requirements. The objective of this research is to systematically analyse the effectiveness of Problem-Based Learning in chemistry education on students' critical thinking skills through a literature review of its implementation in Indonesian higher education institutions.

Research Methodology

This study employs a systematic literature review to analyse the effectiveness of Problem-Based Learning in chemistry on the critical thinking skills of students at Indonesian universities. Data sources were obtained from national and international journals, books and other documents (Eliyah & Aslan, 2025) . Articles were selected using the following inclusion criteria: empirical research articles on PBL in chemistry teaching at higher education institutions, available in Indonesian or English, and published in accredited journals. Data analysis was conducted qualitatively using data reduction, categorisation and synthesis techniques to identify research trends, key findings, strengths and limitations of PBL implementation in enhancing the critical thinking skills of chemistry students (Zed, 2008) .

Results and Discussion

Theoretical Concepts of Problem-Based Learning and Critical Thinking

Problem-Based Learning (PBL) is a learning approach that emphasises the resolution of real-world problems to develop students' critical thinking, problem-solving and independent learning skills (Bell, 2010) . This model was first developed by Barrows and Tamblyn in the 1980s at the Faculty of Medicine, McMaster University, Canada, and has proven effective in problem-solving-focused learning through case studies (Baird, 2019) . PBL is part of Student-Centred Learning, which places students at the centre of the learning process and teachers in the role of facilitators(Widiastuti et al., 2018) .

The key characteristics of Problem-Based Learning encompass five fundamental aspects. Firstly, PBL uses real-world problems as a learning context, making the learning process more meaningful and relevant (Tuhuteru et al., 2023) .

Secondly, this model is student-centred, with students actively constructing their own knowledge through learning activities. Thirdly, PBL emphasises collaborative learning through small-group work, which encourages interaction and discussion amongst students. Fourthly, learning is problem-focused, meaning that students do not need to study unrelated material. Fifthly, scientific activities take place through group work, and students become accustomed to using knowledge sources such as libraries, the internet, interviews and observation (Baird, 2019) .

The Problem-Based Learning approach consists of five main, structured and systematic steps. The first stage is student orientation to the problem, in which the teacher introduces the problem to be studied by the students and helps them to understand the problem and identify its key aspects. The second stage is student organisation for learning, in which the teacher helps students form study groups, define learning objectives, draw up a study plan, and provide the necessary learning resources (San et al., 2020) .

The third stage in the PBL framework is individual and group investigation guidance, during which the teacher provides guidance to pupils as they conduct investigations to solve problems. The teacher encourages pupils to use a variety of learning resources and research methods, and helps them to analyse data and draw conclusions. The fourth stage is the development and presentation of results, in which the teacher helps pupils develop a product or solution to the problem they have been studying and encourages them to present their learning outcomes to others in a creative and engaging manner (Huang et al., 2010) .

The final stage in the PBL framework is the analysis and evaluation of the problem-solving process, in which the teacher helps pupils analyse and evaluate the problem-solving process they have undertaken. The teacher encourages pupils to identify their strengths and weaknesses in problem-solving and helps them develop strategies to improve their abilities (Hendriarto et al., 2021) . These five stages are interrelated and form a complete learning cycle from the beginning to the end of the PBL learning process. According to Facione (2015), critical thinking is purposeful thinking, such as proving a point, interpreting the meaning of something, or solving a problem. Facione describes critical thinking as “purposeful, self-regulatory judgement”, or a conscious and directed assessment that is not merely a matter of logic but also involves self-awareness in evaluating and making decisions. He emphasises that critical thinking comprises two main aspects: cognitive skills and thinking dispositions, which complement one another in the critical thinking process.

Facione explains that there are six key indicators of critical thinking skills involved in the critical thinking process, namely interpretation, analysis, evaluation, inference, explanation and self-regulation. Cognitive skills include the ability to interpret, analyse, evaluate, draw inferences, explain and self-regulate. Meanwhile, thinking dispositions encompass curiosity, openness to new ideas, and intellectual honesty, which are important aspects in shaping a visionary mindset (Facione, 2011) .

Unlike Facione, Robert Ennis views critical thinking from the perspective of the outcome or purpose of thinking, defining it as “reasonable reflective thinking focused on deciding what to believe or do”. In other words, critical thinking helps a person determine what is worth believing and what actions should be taken. Ennis’s approach emphasises the use of logic and evidence in decision-making and argues that critical thinking is not an innate ability but a skill that can be developed through practice in analysis, evaluation and reflection (Ennis, 2015) .

According to Ennis, indicators of critical thinking are divided into five main indicators, namely providing a simple explanation, building basic skills, drawing conclusions, providing further explanations, and devising strategies and tactics. These five indicators are broken down into 12 more detailed and specific sub-indicators to comprehensively measure critical thinking ability (Ennis, 2015) . Both definitions by Facione and Ennis indicate that critical thinking is a complex and structured cognitive process that requires continuous practice.

In the context of chemistry education, chemical literacy and critical thinking are essential for lecturers and students to understand broad and abstract concepts. Indicators of chemical literacy encompass four main aspects: knowledge of chemical material and scientific ideas, chemistry in context, higher-order learning skills, and effectiveness. Meanwhile, according to Ennis, indicators of critical thinking include providing basic explanations, building basic skills, drawing conclusions, providing further explanations, and devising strategies and tactics (Ennis, 2015) .

The theoretical link between Problem-Based Learning and critical thinking skills is very strong, as PBL is designed to develop higher-order thinking skills through complex problem-solving processes . In PBL, students are required to seek out, analyse and evaluate information, make decisions, and solve problems both independently and collaboratively—all of which are core processes in critical thinking. Students become accustomed to using a variety of learning resources and research methods to analyse data and draw conclusions, which form part of Facione’s cognitive skills (Thomas, 2000) .

PBL helps students to better connect what they have learnt with real-world problems, thereby helping them to retain information more effectively. By presenting real-world problems, problem-based learning makes the learning process more meaningful and contextual, encouraging students to think reflectively and critically (Widiastuti et al., 2018) . Scientific activities carried out through group work in PBL encourage students to discuss, argue and evaluate each other’s opinions, which form part of the indicators for assessment and the development of critical thinking (San et al., 2020) .

The conceptual framework for integrating PBL into chemistry teaching at university level is based on cognitive psychology, drawing primarily on the theories of Piaget and Vygotsky, which emphasise the importance of active and constructivist learning. PBL emphasises the integration of theory and practice, as well as content aspects from a range of relevant disciplines, and focuses on the development of learners' problem-solving skills through active and cooperative learning in small groups. This model also supports self-directed learning in the context of finding solutions to various cases and real-world problems, thereby developing self-regulatory skills in critical thinking(Rosidi & Aslan, 2025) .

The implementation of the PBL model in chemistry teaching requires an in-depth understanding of the syntax and characteristics of PBL, as well as indicators of critical thinking, in order to optimise students' learning outcomes. Lecturers must be able to create problems that are authentic and relevant to students' lives, as well as sufficiently complex to challenge them, yet not so difficult as to cause frustration (Hendriarto et al., 2021) . With a clear conceptual understanding of PBL and critical thinking, lecturers can design effective chemistry teaching to enhance students' critical thinking skills in line with the educational needs of the 21st century.

The Effectiveness of PBL Implementation in Chemistry Teaching at Indonesian Universities

The application of the Problem-Based Learning (PBL) model in chemistry teaching at Indonesian universities has proven effective in enhancing students' problem-solving skills, conceptual understanding and critical thinking. Previous research indicates that the application of PBL in chemistry teaching is effective in improving students' problem-solving skills, with an average N-Gain score of 0.71, which falls within the 'high' category. The results of the hypothesis test show that the t-calculated value is greater than the t-table value, namely 25.983 > 2.03011, which proves that the application of the PBL model can improve students' problem-solving skills in the topic of acids and bases (Pratiwi et al., 2025) .

The application of PBL to the topic of chemical equilibrium enhances pupils' conceptual understanding and their ability to analyse and solve complex chemistry problems. Pupils who learn through PBL demonstrate a significant improvement in critical and analytical thinking skills compared to those in the group using conventional teaching methods(Suswati, 2021) . Research conducted by Zakiyah and Ulfa (2017) on the subject of chemical substances yielded an average score of 56.72 in the pre-test and 86.36 in the post-test, with a calculated t-value of 20.42, which is greater than the critical t-value of 2.08; thus, the PBL model is highly effective in the learning process (Zakiyah & Ulfa, 2017) .

The implementation of PBL, supported by handouts, yielded learning outcomes in the subject of stoichiometry, with an average score of 47.5 in the pre-test and 83.66% in the post-test; thus, the PBL model proved highly effective in the learning process. Research conducted at State Senior Secondary School 7 Rejang Lebong showed an improvement in learning outcomes from cycle I to cycle II, from 69.47 to 78.53, with the average percentage rising from 60 per cent to 92 per cent. A comparative study showed that the application of PBL, when compared to the Discovery model, has a higher level of applicability because it is more practical and effective(Murtihapsari et al., 2022) .

The implementation of a general chemistry module using PBL on students' conceptual understanding of stoichiometry demonstrated a significant effect (Pawar et al., 2020) . Research conducted by Putri et al. (2021) on the use of a STEAM-based PBL learning model showed an increase in the average mark from Cycle I to Cycle II, from 70.57 to 81.71 respectively, with the pass rate rising from 40% to 71% respectively; thus, there was a 31% improvement in students' cognitive learning outcomes. A study at Santa Rosa de Lima Catholic High School in Tondano involving Year 10 pupils yielded an average score of 82.66 in the experimental class and 71.33 in the control class, indicating that the average learning outcome in the experimental class was higher than that in the control class(Murtihapsari et al., 2022) .

Variables that influence the effectiveness of PBL include the design of problem scenarios, the lecturer's role as a facilitator, student readiness, and the learning environment and supporting facilities. PBL is closely linked to the development of problem-solving skills because, through PBL, learners are confronted with situations that require critical and creative analysis to find the right solutions. Learners are taught to clearly identify problems and understand the factors influencing them; they must also be able to gather and analyse relevant information to gain a deeper understanding of the problems they face(Murtihapsari et al., 2022) .

Designing appropriate problem scenarios is a key factor in the implementation of PBL, as the problems must be authentic and relevant to students' lives, as well as sufficiently complex to challenge them without being so difficult as to cause frustration. PBL guides learners to conduct research, engage in discussion and undertake independent exploration until they find solutions based on existing knowledge or by learning new concepts. The role of the lecturer as a facilitator is vital in guiding students when necessary, but not as the primary source of information(Mudinillah et al., 2024) . Students' readiness for independent learning is a crucial factor, as PBL emphasises collaboration amongst students who work together in groups to share ideas, test hypotheses and find the best solutions. The main principle of PBL is to teach students to learn independently, whereby they play an active role in finding solutions to a problem presented to them. The learning environment and supporting resources, such as worksheets, handouts, modules and virtual learning media, also influence the effectiveness of PBL implementation (Murtihapsari et al., 2022) .

The advantages of implementing PBL in the context of chemistry education at Indonesian universities encompass five main aspects. Firstly, students are encouraged to develop problem-solving skills in real-life situations, which makes learning more contextual. Secondly, students acquire the skills to build their own knowledge through learner-centred learning activities. Thirdly, learning is problem-centred, meaning that students do not need to study unrelated material, making the process more efficient (Pratiwi et al., 2025) .

Fourthly, scientific activities take place through group work, which develops communication and teamwork skills. PBL promotes a learner-centred approach to learning, in which students play an active role in finding solutions to the problems presented. Fifthly, students become accustomed to using knowledge sources from libraries, the internet, interviews and observations, which develop higher-order learning skills. PBL also makes the study of chemistry more contextual and relevant to everyday life, which has a positive impact on learning motivation and leads to better learning outcomes (Pratiwi et al., 2025) .

PBL helps students to better link what they have learnt to real-world problems, thereby helping them to retain information more effectively. PBL not only enhances understanding of chemical concepts but also strengthens problem-solving skills, which are essential in science education (Widiastuti et al., 2018) . These findings reinforce the view that the PBL model is effective in improving conceptual understanding and critical thinking skills in chemistry.

The limitations and challenges of implementing PBL in Indonesian higher education institutions include limited teaching time, a heavy curriculum workload, variations in lecturers' competencies, and a lack of supporting facilities. Lecturers still use conventional teaching methods, such as lectures, to present material, which leads to students becoming bored and failing to fully understand the subject matter. A lecturer's teaching style plays a crucial role in fostering students' interest and enhancing their learning outcomes. Limited teaching time is a major obstacle, as PBL requires more time for problem orientation, group discussions, independent investigation, presentation of findings, and process evaluation. A heavy curriculum workload also limits teachers' flexibility to implement PBL optimally in the classroom. Variations in lecturers' competencies present a challenge, as lecturers who lack a thorough understanding of the learning model to be implemented are unable to develop effective learning models to develop students' skills(Murtihapsari et al., 2022).

Limitations in supporting resources such as worksheets, handouts, modules and virtual learning media also affect the effectiveness of PBL implementation in Indonesian higher education institutions. Teachers do not encourage two-way discussion between themselves and students during lessons, meaning that interaction in the learning process is less than optimal. The success of education depends on the interaction between teachers and students in the learning process, which requires innovation and creativity from teachers to apply more interactive and effective learning models (Musa et al., 2012) .

A synthesis of research findings indicates that PBL consistently improves learning outcomes in chemistry, critical thinking skills and problem-solving across various subjects and at higher education institutions in Indonesia. Research based on 24 articles shows that the use of the PBL model in the learning process leads to an improvement in students' learning outcomes, as they become more responsive in actively solving problems related to the subject matter, and think critically, creatively and independently when answering questions. There is a significant correlation between the implementation of PBL and critical thinking, as well as a significant correlation between scientific argumentation skills and cognitive learning outcomes(Murtihapsari et al., 2022) .

Remaining research gaps include the need for further research into the optimisation of PBL through the integration of digital technology, a comparison of the effectiveness of PBL with other learning models, and the development of PBL-integrated chemistry teaching materials that are more valid and appropriate. Research on the development of PBL-integrated Basic Chemistry I teaching materials showed that the materials were deemed valid and highly suitable, with an average score of 3.96 for content suitability, 3.88 for linguistic suitability, 3.85 for presentation suitability, and 3.88 for graphical suitability. The effectiveness of using PBL-integrated Basic Chemistry I teaching materials in improving student achievement showed an effectiveness rate of 73.45% in the control class and 81.81% in the experimental class (Rahmawati et al., 2025) .

Conclusion

Chemistry teaching based on Problem-Based Learning (PBL) has proven effective in enhancing students' critical thinking skills at Indonesian universities. The implementation of PBL has shown a significant improvement in chemistry learning outcomes, problem-solving skills and conceptual understanding, with an average N-Gain score of 0.71 in the high category. The PBL framework, comprising five stages (problem orientation, learning organisation, investigation, presentation of results and evaluation), provides a systematic learning structure for developing critical thinking skills in line with the indicators proposed by Facione and Ennis.

The implementation of PBL in Indonesian higher education institutions faces challenges such as time constraints, a heavy curriculum workload, variations in lecturers' competencies, and limited supporting resources; however, it still offers advantages in making chemistry learning more contextual, encouraging independent learning, and developing collaborative skills. Lecturers need to optimise their role as facilitators, design authentic problem scenarios, and provide adequate learning resources to maximise the effectiveness of PBL. Recommendations for further research include the development of more valid PBL-integrated chemistry teaching materials, the integration of digital technology into PBL, and a comparison of the effectiveness of PBL with other learning models to provide practical guidance for chemistry education in Indonesian higher education institutions.

References

Aslan, A., & Imelda, I. (2025). EVALUATION OF THE EFFECTIVENESS OF TECHNOLOGY-BASED LEARNING PROCESSES AND OUTCOMES IN IMPROVING STUDENT COMPETENCE, MOTIVATION, AND ENGAGEMENT: A LITERATURE REVIEW OF DIGITAL ASSESSMENT MODELS IN THE ERA OF EDUCATION 4.0 TRANSFORMATION. *Indonesian Journal of Education (INJOE)*, *5*(1), 240–251.

Baird, M. (2019). *Project Based Learning to Develop 21st Century Competencies*. https://pressbooks.pub/techandcurr2019/chapter/pbl-competencies/

Bell, S. (2010). Project-Based Learning for the 21st Century: Skills for the Future. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(2), 39–43. https://doi.org/10.1080/00098650903505415

Busnawir, & Aslan, A. (2026). THE APPLICATION OF PROJECT-BASED LEARNING TO ENHANCE CREATIVITY AND COLLABORATIVE SKILLS AMONG PRIMARY SCHOOL PUPILS IN THE ERA OF THE MERDEKA CURRICULUM. *Indonesian Journal of Education (INJOE)*, *5*(2), 364–378.

Eliyah, E., & Aslan, A. (2025). STAKE'S EVALUATION MODEL: METODE PENELITIAN. *Prosiding Seminar Nasional Indonesia*, *3*(2), Article 2.

Elmiwati, E., & Aslan, A. (2025). THE PHILOSOPHY AND CONCEPT OF THE LOVE CURRICULUM IN EDUCATION: A LITERATURE REVIEW ON INSTILLING THE VALUES OF LOVE, EMPATHY, TOLERANCE, AND HARMONY BASED ON ISLAMIC EDUCATION, HUMANISM, AND THE THEORY OF LOVE. *International Journal of Teaching and Learning*, *3*(2), 124–132.

Ennis, R. H. (2015). Critical Thinking: A Streamlined Conception. In M. Davies & R. Barnett (Eds.), *The Palgrave Handbook of Critical Thinking in Higher Education* (pp. 31–47). Palgrave Macmillan US. https://doi.org/10.1057/9781137378057_2

Facione, P. A. (2011). Critical thinking: What it is and why it counts. *Insight Assessment*, *1*(1), 1–23.

Firdausih, F., & Aslan, A. (2024). LITERATURE REVIEW: THE EFFECT OF PROJECT-BASED LEARNING ON STUDENT MOTIVATION AND ACHIEVEMENT IN SCIENCE. *Indonesian Journal of Education (INJOE)*, *4*(3), Article 3.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, *54*, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hendriarto, P., Aslan, A., Mardhiah, Sholihin, R., & Wahyudin. (2021). The Relevance of Inquiry-Based Learning in Basic Reading Skills Exercises for Improving Student Learning Outcomes in Madrasah Ibtidaiyah. *At-Tajdid : Jurnal Pendidikan Dan Pemikiran Islam*, *5*(01), 28–41. https://doi.org/10.24127/att.v5i01.1473

Huang, H.-M., Rauch, U., & Liaw, S.-S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education*, *55*(3), 1171–1182. https://doi.org/10.1016/j.compedu.2010.05.014

Lewis, C. W., & Gilman, S. (2005). *The ethics challenge in public service: A problem-solving guide* (2nd ed). Jossey-Bass.

Mudinillah, A., Kuswandi, D., Erwin, E., Sugiarni, S., Winarno, W., Annajmi, A., & Hermansah, S. (2024). Optimizing Project-Based Learning in Developing 21st

Century Skills: A Future Education Perspective. *Qubahan Academic Journal*, *4*(2), 86–101. https://doi.org/10.48161/qaj.v4n2a352
Murtihapsari, M., Achmad, F., Larasati, C. N., & Yogaswara, R. (2022). Penggunaan Model Pembelajaran Problem Based Learning Terhadap Minat Hasil Belajar Kimia pada Peserta Didik. *Jambura Journal of Educational Chemistry*, *4*(2), 64–69. https://doi.org/10.34312/jjec.v4i2.14050
Musa, F., Mufti, N., Latiff, R. A., & Amin, M. M. (2012). Project-based Learning (PjBL): Inculcating Soft Skills in 21st Century Workplace. *Procedia - Social and Behavioral Sciences, Universiti Kebangsaan Malaysia Teaching and Learning Congress 2011, Volume I, December 17 – 20 2011, Pulau Pinang MALAYSIA*, *59*, 565–573. https://doi.org/10.1016/j.sbspro.2012.09.315
Pawar, R., Kulkarni, S., & Patil, S. (2020). Project Based Learning: An Innovative Approach for Integrating 21st Century Skills. *Journal of Engineering Education Transformations*, 58–63. https://doi.org/10.16920/jeet/2020/v33i4/139423
Pratiwi, D. E., Erna, M., & Anwar, L. (2025). Penerapan Model Pembelajaran Problem Based Learning (PBL) untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik Pada Materi Asam Basa. *Chemistry Education Practice*, *8*(2), 302–311. https://doi.org/10.29303/cep.v8i2.9392
Rahmawati, N., Simbolon, M. E., & Nugraha, F. F. (2025). *PENGARUH MODEL PEMBELAJARAN PROJECT BASED LEARNING (PJBL) TERHADAP KREATIVITAS SISWA*. https://ejournal.ust.ac.id/index.php/Aquinas/article/download/4919/3581
Redhana, I. W. (2019). MENGEMBANGKAN KETERAMPILAN ABAD KE-21 DALAM PEMBELAJARAN KIMIA. *Jurnal Inovasi Pendidikan Kimia*, *13*(1). https://doi.org/10.15294/jipk.v13i1.17824
Rosidi, M. I., & Aslan, A. (2025). IMPLEMENTATION OF THE LOVE CURRICULUM IN SHAPING CHARACTER BASED ON COMPASSION IN STUDENTS AND ITS IMPACT ON HARMONIOUS RELATIONSHIPS BETWEEN EDUCATORS AND STUDENTS: A LITERATURE REVIEW. *International Journal of Teaching and Learning*, *3*(2), 191–201.
San, A. M., Chotikakamthorn, N., & Sathitwiriyawong, C. (2020). Blockchain-based Learning Credential Revision and Revocation Method. *Proceedings of the 21st Annual Conference on Information Technology Education, SIGITE '20*, 42–45. https://doi.org/10.1145/3368308.3415456
Subagia, I. W. (2014). PARADIGMA BARU PEMBELAJARAN KIMIA SMA. *Prosiding Seminar Nasional MIPA*. https://ejournal.undiksha.ac.id/index.php/semnasmipa/article/view/10479
Suswati, U. (2021). *Penerapan Problem Based Learning (Pbl) Meningkatkan Hasil Belajar Kimia. TEACHING: Jurnal Inovasi Keguruan Dan Ilmu Pendidikan, 1 (3), 127–136*.
Thomas, J. W. (2000). *A review of research on project-based learning*. California. https://tecfa.unige.ch/proj/eteach-net/Thomas_researchreview_PBL.pdf
Tuhuteru, L., Misnawati, D., Aslan, A., Taufiqoh, Z., & Imelda, I. (2023). The Effectiveness of Multimedia-Based Learning To Accelerate Learning After The Pandemic At The Basic Education Level. *Tafkir: Interdisciplinary Journal of Islamic Education*, *4*(1), 128–141. https://doi.org/10.31538/tijie.v4i1.311

Wicaksono, B. W. (2021). Peran Pendidikan Agama Islam dalam Membangun Karakter Mahasiswa di Era Milenial. *Tarbiyatu wa Ta'lim*, *3*(1), 1–9.

Widiastuti, A., Istihapsari, V., Afriady, D., Lhi Banguntapan, S., & Wirobrajan, S. M. (2018). Meningkatkan Kreativitas Siswa Melalui Project Based Learning pada Siswa Kelas V SDIT LHI. *Prosiding Pendidikan Profesi Guru Fakultas Keguruan Dan Ilmu Pendidikan*, 1430–1440.

Zakiyah, H., & Ulfa, N. (2017). Pengaruh model pembelajaran pbl (problem based learning) terhadap hasil belajar siswa pada materi bahan kimia dalam kehidupan sehari-hari. *Lantanida Journal*, *5*(2), 106–118.

Zed, M. (2008). *Metode Penelitian Kepustakaan*. Yayasan Pustaka Obor Indonesia.

Zeichner, K. (2010). Rethinking the Connections Between Campus Courses and Field Experiences in College- and University-Based Teacher Education. *Journal of Teacher Education*, *61*(1–2), 89–99. https://doi.org/10.1177/0022487109347671