

Understanding and Interpreting the Problem-Based Learning Model Based on Blended Learning in High School Learning

Wita Ferwati^{1,2}, Abdul Hasan Saragih², Harun Sitompul³

1Faculty of Teacher Training and Education, Biology Education, Universitas Al Washliyah
Labuhanbatu, Rantauprapat, Indonesia

2,3,4Educational Teknologi, Universitas Negeri Medan, Medan, Indonesia

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ABSTRACT:

Abstract—21st-century learning demands the application of methods capable of enhancing critical thinking skills and active student participation. Problem-Based Learning (PBL) based on Blended Learning is one approach that integrates online and offline learning while emphasizing real-world problem solving. This article discusses the concept, principles, and development of a PBL model based on Blended Learning in a secondary school context. The methods used are literature study and conceptual analysis, with a focus on model development strategies, learning design, and evaluation of student learning outcomes. The analysis results indicate that this model is effective in increasing student engagement, critical thinking skills, and learning effectiveness, especially when teachers integrate technology with collaborative and reflective activities. These findings provide practical guidance for educators in designing more interactive, relevant, and student-centered learning.

Keywords: Problem-Based Learning, Blended Learning, Model Development, Secondary School, Interactive Learning

I. INTRODUCTION

The development of science and technology in the 21st century brings major challenges to the world of education. The learning process is no longer solely focused on knowledge transfer, but must also develop students' critical thinking skills, problem-solving, creativity, and collaborative abilities [1], [2]. This need demands innovation in learning strategies so that students are able to face the dynamics of the modern world. In addition, rapid social and economic changes also influence the competency demands of the younger generation. Students are not only expected to master academic content, but also to be able to apply knowledge in real contexts, adapt to change, and be proactive in solving problems [1], [3]. This

emphasizes the importance of a learning approach that emphasizes the development of higher-order thinking skills.

In this context, Problem-Based Learning (PBL) emerged as a learning model capable of training critical thinking skills and problem-solving abilities. PBL emphasizes the use of real problems as learning stimuli so that students are encouraged to explore, analyze, and evaluate information in depth [2], [6]. This process also encourages students to work independently and collaboratively, increasing their sense of responsibility for their own learning process. Several studies have shown that the implementation of PBL can improve students' learning outcomes, motivation, and problem-solving skills at various levels of education [8], [9].

PBL not only focuses on mastery of the material, but also on the learning process itself, where metacognitive, communication, and collaboration skills develop as the learning activity progresses [3], [6].

However, the implementation of PBL is not without its challenges. Some frequently encountered challenges include limited face-to-face time, student initial readiness, and a lack of technological support in learning activities [3], [5]. These obstacles can hinder the effectiveness of PBL if not addressed through adaptive and flexible learning strategies. Blended Learning has emerged as a solution to address these limitations. This model combines face-to-face learning with online learning, providing students with flexibility in accessing materials, engaging in discussions, and interacting with teachers and peers [4], [5]. This approach allows for a continuous learning process, both inside and outside the classroom.

Previous research has shown that Blended Learning is effective in enhancing students' learning independence, motivation, and critical thinking skills [7], [10]. By utilizing technology, students can access a wide range of learning resources, engage in independent reflection, and solve problems through structured online discussions. The integration of PBL with Blended Learning has the potential to produce a more interactive and adaptive learning model. This combination allows students to learn through real-world problems while still utilizing digital media to support exploration, collaboration, and reflection [2], [4]. This model is also in line with the demands of the Independent Curriculum and 21st-century learning approaches that emphasize critical, creative, and communicative thinking skills.

From a pedagogical perspective, the integration of PBL and Blended Learning offers a holistic approach that balances the development of knowledge, skills, and attitudes. Students not only master academic content but are also trained to think analytically, collaborate, and independently [6], [7]. This is crucial to equip them to face global challenges and an increasingly complex workplace. Furthermore, this model encourages teachers to act as facilitators and guides, not simply as

transmitters of information. Teachers are tasked with designing problems, facilitating discussions, and providing constructive feedback, making the learning process more meaningful and focused [5], [8]. This teacher role is crucial to ensuring each student can develop their maximum potential.

In practice, implementing PBL based on Blended Learning requires a solid understanding of learning design principles, technology utilization, and effective classroom management. Teachers need to design problem scenarios, online modules, and collaborative activities that align with learning objectives [3], [9]. From the student perspective, this model demands active participation and independence in learning. The ability to manage time, communicate, and work in teams are key competencies developed through this learning process [2], [10]. Thus, this model not only improves academic outcomes but also relevant life skills.

This article aims to introduce the basic concepts, principles, and development stages of a blended learning-based PBL model in a secondary school context. This study also explores the implications of its application on student engagement, motivation, and learning outcomes, as well as potential implementation challenges. By understanding the concepts and application of this model, educators are expected to gain a comprehensive understanding of how to design innovative, relevant, and student-centered learning strategies. Furthermore, this article is expected to contribute to the development of effective learning practices in the digital age and prepare students for the challenges of the 21st century.

II. LITERATURE SURVEY

1. Problem-Based Learning (PBL)

Problem-Based Learning (PBL) is a learning model oriented toward solving real-world problems to develop students' critical, analytical, and collaborative thinking skills. In PBL, students play an active role as problem solvers, while the teacher acts as a facilitator guiding the learning process [2], [6]. PBL encourages students to develop a deep understanding of concepts through contextual learning experiences relevant to everyday life. Hmelo-Silver and Eberbach [6] explain that PBL is

based on constructivist theory, where students construct their own knowledge through experience, reflection, and social interaction. The collaborative process in PBL allows students to share ideas, evaluate alternative solutions, and systematically develop problem-solving strategies.

Research by Batdi and Talan [2] shows that consistent implementation of PBL can significantly improve students' academic achievement, including critical thinking skills, problem-solving skills, and social and collaborative skills. Furthermore, PBL has also been shown to increase student motivation and active participation in learning [6], [8]. The implementation of PBL in secondary schools, particularly in science and biology subjects, requires adaptation to the complexity of the material and student readiness. Strategies such as providing contextual problems, scaffolding guides, and the use of digital media can support the effectiveness of PBL [3], [9].

2. Blended Learning

Blended Learning is a combination of face-to-face (offline) learning and online learning utilizing digital technology [4]. This model provides flexibility for students to learn according to their needs and time, while still receiving direct guidance from teachers [5]. With this approach, students can review material, access additional learning resources, and discuss with friends and teachers outside of class.

According to Dhawan [4], Blended Learning is a strategic solution in addressing changes in the modern education system, especially in the post-COVID-19 pandemic era, because it integrates technology with active pedagogy. Kasim and Khalid [7], in their systematic review, found that Blended Learning contributes positively to improving critical thinking skills, learning independence, and student participation. Blended Learning also supports the principle of student-centered learning, where students are responsible for their own learning process. Through digital platforms, teachers can monitor learning progress, provide feedback, and adapt materials to students' needs [5], [10]. This technological integration enables learning to be continuous and adaptive to students' circumstances.

3. Integration of PBL and Blended Learning

The integration of PBL with Blended Learning is a learning innovation that combines the advantages of both models. This model allows students to solve real-world problems through a collaborative approach, while leveraging the flexibility of technology to access materials and discuss them online [1], [10]. This integration overcomes constraints such as limited face-to-face time in PBL. Students can study the material before face-to-face meetings, engage in synchronous or asynchronous discussions, and work on collaborative assignments using digital platforms [4], [9].

Research by Sari and Sudibjo [9] shows that the PBL model based on Blended Learning can significantly improve students' problem-solving and critical thinking skills. Furthermore, Sa'adah and Sari [8] confirm the effectiveness of this model in increasing student motivation, active participation, and engagement in biology learning in high school. The integration of PBL and Blended Learning not only facilitates the achievement of academic goals but also develops students' soft skills, such as communication, collaboration, and time management.

4. 21st-Century Education

21st-century education demands mastery of critical thinking, creativity, communication, and collaboration (the 4Cs) [1], [7]. Modern curricula emphasize student-centered learning, where students are at the center of the learning process and teachers act as facilitators. Learning models that emphasize problem-solving, reflection, and collaboration are highly relevant in this context.

Alshammari [1] states that the implementation of Blended Learning combined with PBL can significantly improve students' critical thinking skills. This model allows students to actively participate in learning, explore knowledge, and connect academic concepts to real-world situations. The integration of PBL and Blended Learning aligns with the needs of 21st-century competencies, as it emphasizes not only content mastery but also the development of critical thinking, creativity, communication, and collaboration skills. With this approach, students

are better prepared to face global challenges and the needs of the future workforce [2], [6], [10].

5. Critical Thinking Skills in Blended Learning-Based PBL

Critical thinking skills are the primary goal of blended learning-based PBL. Students are trained to analyze problems, evaluate information from various sources, and formulate logical solutions [2], [7]. Blended learning supports this process by providing diverse learning resources, online discussion forums, and media for individual and group reflection.

According to Facione [11], critical thinking skills include the ability to analyze, evaluate, and make evidence-based decisions. Blended learning-based PBL provides a real-world context for students to practice these skills, making the learning process more meaningful and relevant.

6. Student Learning Motivation

Learning motivation is a crucial factor in the success of Blended Learning-based PBL. Research by Ryan and Deci [12] emphasizes the importance of intrinsic motivation in encouraging student engagement in active learning. With Blended Learning, students have the freedom to organize their time and learning methods according to their interests, thus increasing their learning motivation [5], [8].

The integration of PBL provides challenges that require critical thinking, problem-solving, and collaboration, which can increase students' self-confidence and intrinsic motivation. This aligns with the findings of Sa'adah and Sari [8], who stated that active participation in Blended Learning-based PBL increases student engagement and motivation in biology learning.

Furthermore, student learning motivation is also influenced by emotional engagement and meaningful learning experiences. According to Deci and Ryan [12], when students feel competent, autonomous, and connected to their classmates, their intrinsic motivation increases, thus encouraging active participation in every stage of learning. Blended Learning provides opportunities for students to reflect on the learning process, receive feedback from teachers and peers, and

manage their own learning progress, thus increasing their learning motivation.

In addition, the use of interactive digital media, such as videos, simulations, and discussion forums, can also trigger students' curiosity and interest in learning. Motivated students tend to be more proactive in finding solutions, collaborating with friends, and applying learned concepts in real-life situations [7], [10]. This shows that learning motivation is not only determined by the content of the material, but also by the design of learning experiences that are challenging and support the development of cognitive and social skills.

7. Challenges and Implementation Strategies

Although Blended Learning-based PBL offers many benefits, its implementation also faces challenges. Some obstacles include limited student digital literacy, teacher preparedness, and technical constraints and internet access [3], [4]. The digital proficiency gap between students can lead to unequal participation in online activities, necessitating interventions to ensure all students can participate effectively in the learning process.

Strategies to address these challenges include regular teacher training to improve pedagogical and technological competencies, providing structured and easily accessible online materials, and selecting user-friendly platforms. Continuous monitoring and evaluation are also crucial to identify student difficulties, provide timely feedback, and adjust learning strategies [9], [10].

Furthermore, parental and school community involvement can support successful implementation. For example, parents can motivate students to study independently at home, while schools provide adequate internet access and digital devices. A collaborative approach between teachers, students, and parents will enhance the effectiveness of Blended Learning-based PBL and ensure optimal achievement of learning objectives [5], [8]. Finally, careful time management and lesson planning are key. Teachers need to design a balanced schedule between face-to-face and online activities, provide challenges that are appropriate to students' abilities, and ensure that each student has the opportunity to be actively involved in the problem-solving process [4], [7]. With this strategy,

technical and motivational obstacles can be minimized, so that Blended Learning-based PBL can be implemented effectively.

III. EXISTING METHODOLOGY

This article uses a literature research approach with a conceptual analysis of various previous studies on Problem-Based Learning (PBL), Blended Learning, and their integration in a secondary school context. This literature study was chosen because the purpose of the research was not to conduct empirical testing, but rather to understand the concepts, principles, and development stages of a Blended Learning-based PBL model. The data collection process was conducted through a review of relevant journal articles, books, and international and national proceedings, particularly publications published between 2020 and 2025. Literature sources were obtained from academic databases such as Scopus, Springer, Wiley, and Google Scholar. The analysis was conducted in several stages. First, literature identification was carried out by selecting publications related to PBL, Blended Learning, or the integration of the two [2], [4], [6]. Second, the literature was classified based on the main themes: (1) basic concepts of PBL, (2) implementation of Blended Learning, (3) development of a Blended Learning-based PBL model, and (4) relevance to 21st-century learning [1], [7], [9]. Third, content analysis is conducted by comparing the results of previous research to identify the strengths, limitations, and opportunities for model development. The results of the conceptual analysis are then used to formulate a framework for developing a blended learning-based PBL model in secondary school learning. Thus, this methodology produces a comprehensive study that can serve as a basis for developing innovative learning models and as a reference for educators in designing learning strategies that meet the needs of the 21st century [5], [8], [10].

IV. RESULTS AND DISCUSSION

1. Characteristics of the Blended Learning-Based PBL Model

The literature review shows that Blended Learning-based PBL has the main characteristic of combining real-world problem solving with the

integration of digital technology. This model places students at the center of learning, while the teacher acts as a facilitator [2], [6]. PBL encourages students to develop critical and creative thinking skills, while Blended Learning provides flexibility in time and access to learning resources [4], [5].

Research by Alshammari [1] demonstrated that the implementation of PBL-based Blended Learning significantly improved the critical thinking skills of high school students. Furthermore, the interactive characteristics of Blended Learning, such as online discussion forums, online quizzes, and multimedia, support student reflection and collaboration, making the learning experience more meaningful and in-depth.

This model also allows for learning differentiation, allowing students to learn at their own pace and learning style. The integration of digital technology allows teachers to provide additional material for students who need more in-depth study, as well as provide challenges for students who grasp concepts

more quickly [7], [10].

2. Model Development Strategy

The integration of PBL and Blended Learning is carried out through several strategies, namely:

- Use of a Learning Management System (LMS) such as Moodle or Google Classroom for material distribution, discussion forums, and assessments [4], [10].
- The Flipped Classroom approach, where students study basic material online before face-to-face sessions, allowing class time to be used for discussion, collaboration, and problem-solving [7], [9].
- Online and offline collaboration, which combines face-to-face activities with online group work, thereby increasing student academic interaction [5], [8].

These strategies demonstrate that developing PBL-based Blended Learning requires careful learning design planning so that both approaches complement each other. Good planning includes determining learning objectives, the flow of online and face-to-face activities, media selection, and

ongoing evaluation of student learning progress [3], [6].

Furthermore, teachers need to ensure adequate scaffolding to support students in problem-solving, both individually and in groups. The use of clear assessment rubrics and regular feedback also plays an important role in maintaining the quality of learning and increasing student learning motivation [8], [9].

3. Impact on Secondary School Learning

Several studies have found that the implementation of Blended Learning-based PBL has a positive impact on student engagement, motivation, and learning outcomes. Sari and Sudibjo [9] demonstrated that the integration of the two models can improve problem-solving skills and learning independence. Sa'adah and Sari [8] also reported that students were more motivated and active in biology learning when using this model.

Furthermore, Blended Learning can overcome the limitations of PBL, which is often limited by face-to-face time. Through online access to materials, students have the opportunity for deeper independent learning, while face-to-face sessions are used for collaborative discussions [3], [4].

The implementation of this model also aligns with the demands of 21st-century education, which emphasizes critical thinking, collaboration, communication, and creativity (the 4Cs) [1]. With Blended Learning-based PBL, students not only master academic content but are also trained to manage time, collaborate, and think creatively in solving real-life problems.

Furthermore, the implementation of this model can strengthen students' metacognitive skills. Reflection activities, online discussions, and peer reviews allow students to assess their own learning progress, evaluate the strategies used, and identify areas for improvement [5], [7]. This forms an independent learning attitude which is an important competency for 21st-century education.

4. Challenges and Opportunities

Despite its many advantages, the implementation of Blended Learning-based PBL also faces a number of challenges. These challenges include

teacher readiness in designing technology-based learning, students' digital skills, and the availability of adequate infrastructure [3], [5]. Difficulty in internet access, differences in digital literacy skills, and lack of experience using an LMS can be barriers that affect the effectiveness of this model.

However, the opportunities for developing this model are significant, especially with the support of education policies that encourage school digitalization and the implementation of the Independent Curriculum, which focuses on strengthening 21st-century competencies. Government and school support in the form of teacher training, provision of digital devices, and development of online learning content will strengthen the implementation of Blended Learning-based PBL [4], [10].

Furthermore, collaboration with educational institutions, educational technology practitioners, and the academic community can provide additional innovations, such as the development of digital simulations, interactive learning platforms, and technology-based evaluation media. This opportunity opens up the possibility of a more adaptive and personalized model that can effectively address students' learning challenges [6], [9].

Thus, it can be concluded that the development of Blended Learning-based PBL has the potential to be an innovative solution for improving the quality of secondary school learning. This model is not only able to develop critical thinking skills, but also increases students' motivation, participation, and learning independence, while strengthening 21st-century competencies that are relevant to the needs of the modern world.

5. Pedagogical and Theoretical Alignment

The development of a Blended Learning-based PBL model is strongly grounded in contemporary learning theories that emphasize active knowledge construction, social interaction, and digital connectivity. Recent studies highlight that constructivist-oriented learning environments enable students to build conceptual understanding through engagement with authentic problems supported by technology-enhanced learning spaces [11], [12]. In this context, PBL serves as a catalyst

for meaningful learning, while Blended Learning provides flexibility and continuous access to diverse learning resources.

From a socio-constructivist perspective, the integration of online and face-to-face learning supports collaborative knowledge construction. Digital discussion forums, collaborative documents, and synchronous online interactions facilitate peer learning and scaffolding, which are essential for developing higher-order thinking skills [13], [14]. These learning conditions allow students to negotiate meaning, reflect on alternative solutions, and refine their understanding through guided interaction.

In addition, recent literature emphasizes the relevance of connectivist principles in blended environments, where learning is distributed across networks of information sources, digital tools, and social connections. Blended Learning enables students to develop the ability to navigate, evaluate, and integrate information from multiple digital sources, which is increasingly recognized as a critical competence in modern education [15], [16].

6. Implications for Instructional Design and Teacher Roles

The implementation of Blended Learning-based PBL requires a shift in the teacher's role from content delivery to instructional design and facilitation. Teachers are expected to design problem scenarios that are contextually relevant, organize learning sequences across online and offline environments, and provide timely feedback to support student learning processes [17], [18]. This instructional approach encourages active participation and sustained engagement throughout the learning cycle. Effective instructional design in blended PBL environments typically includes structured pre-class online activities, interactive face-to-face problem-solving sessions, and post-class reflection and reinforcement activities. Empirical evidence suggests that such structured designs improve conceptual understanding, learning retention, and student autonomy when compared to traditional instructional approaches [19], [20]. Assessment practices within this model also emphasize

authentic and performance-based evaluation. Digital portfolios, project-based assessments, and reflective journals are widely recommended to capture both cognitive learning outcomes and transversal skills such as collaboration, critical thinking, and self-regulation [21]. These assessment strategies align well with the objectives of PBL and the affordances of digital learning environments.

7. Relevance to Digital Transformation and 21st-Century Learning

Blended Learning-based PBL is highly relevant to the ongoing digital transformation of education, particularly in response to the increasing demand for flexible, resilient, and learner-centered instructional models. Recent studies indicate that blended instructional approaches enhance students' digital literacy, learning independence, and adaptability in technology-rich learning contexts [22], [23]. In the post-pandemic educational landscape, Blended Learning has become a strategic approach rather than a supplementary option. It supports continuity of learning while fostering essential 21st-century skills, including critical thinking, communication, collaboration, and creativity. When integrated with PBL, this approach enables students to apply knowledge in real-world contexts while developing problem-solving and decision-making abilities [24].

Moreover, the reflective components embedded in Blended Learning-based PBL—such as online discussions, peer feedback, and self-assessment—contribute to the development of metacognitive skills. These skills are crucial for lifelong learning, as they enable students to monitor their own learning progress, adjust strategies, and take responsibility for their learning outcomes [25], [26].

V. CONCLUSION

This chapter presents the findings from the suggested work and future scope of this model.

Conclusion

The results of the literature review indicate that Problem-Based Learning (PBL) based on Blended Learning is an innovative learning model capable of meeting the demands of 21st-century education. The integration of these two approaches offers

dual advantages: PBL fosters critical thinking, problem-solving, and collaboration skills, while Blended Learning offers flexibility, access to digital learning resources, and increased interactivity [1], [4], [9]. Previous research has shown that the implementation of Blended Learning-based PBL can increase student engagement, learning motivation, and the effectiveness of academic achievement [2], [5], [8].

Thus, it can be concluded that the development of a Blended Learning-based PBL model has great potential for implementation in secondary schools,

particularly in strengthening 21st-century competencies such as critical thinking, creativity, communication, and collaboration (4C).

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