

Enhancing Education Through Online Project-Based Learning (PBL): Strategies, Challenges, and Outcomes in the Digital Era

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Accepted: Sept 28 th 2024	Reviewed: Oct 18 th 2024	Published: Nov 30 th 2024
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Abstract

This study explores the application of Online Project-Based Learning (PBL) as an innovative pedagogical model designed to enhance student engagement and skill development in the digital era. With the rise of information and communication technologies, Online PBL has emerged as a flexible and accessible alternative to traditional learning methods. This research examines various online PBL models implemented in educational settings, focusing on platforms like Learning Management Systems (LMS), social media integration, and online collaboration tools such as Google Workspace and Microsoft Teams. The findings highlight the benefits of these models in fostering critical thinking, collaboration, and technological proficiency. However, the study also identifies challenges such as limited access to technology, the lack of face-to-face interaction, and difficulties in assessing student performance. The paper concludes with recommendations for overcoming these challenges, including teacher training, improved technological infrastructure, and curriculum adjustments to support the successful integration of online PBL. The implications for future educational practices and the continued evolution of PBL in digital learning environments are discussed.

Keywords: Project-Based Learning, PBL, Learning Models



By Authors

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Introduction

The field of education has undergone profound transformations in recent decades, largely driven by advancements in information and communication technology (ICT). These technological developments have reshaped the ways in which knowledge is disseminated and acquired, demanding more flexible, accessible, and engaging learning models. As education systems adapt to the evolving needs of the digital age, one approach that has gained significant attention is Project-Based Learning (PBL). PBL is an instructional strategy that emphasizes student-centered learning through the completion of real-world projects. It encourages students to engage in research, problem-solving, and collaboration, thereby fostering critical thinking and

practical skills¹. Given the increasing importance of preparing students for an ever-changing job market, PBL has emerged as a promising tool to develop 21st-century skills such as creativity, teamwork, and communication².

At its core, PBL provides a structured environment where students work collaboratively to address complex, real-world issues. Traditional PBL has predominantly been implemented in face-to-face settings, allowing for direct interaction between students, teachers, and external stakeholders. However, the rapid integration of technology into education has paved the way for the development of Online Project-Based Learning (Online PBL). Online PBL offers significant advantages by enabling students to collaborate on projects regardless of geographical location, thus broadening access to education and creating opportunities for learning beyond the physical classroom (Lestari et al., 2020). This model not only enhances engagement but also supports personalized learning, where students can progress at their own pace, tailor their learning experiences, and work within their preferred modes of communication³.

The transition from traditional to online learning environments, accelerated by the COVID-19 pandemic, has highlighted the need for educational approaches that foster sustained student engagement in virtual spaces. The shift to online education has underscored the necessity for flexible learning models capable of maintaining student motivation, fostering interaction, and ensuring academic rigor. In this context, Online PBL offers a viable solution, facilitating collaborative learning through digital platforms such as Learning Management Systems (LMS), social media, and online collaboration tools like Google Workspace and Microsoft Teams. These platforms enable students to interact asynchronously or synchronously, share resources, manage projects, and receive feedback from peers and instructors⁴. Furthermore, the incorporation of multimedia tools and digital resources in online PBL projects promotes greater engagement and skill development, especially in digital literacy, which is crucial in today's technology-driven society⁵.

However, while Online PBL presents clear advantages, it also brings forth several challenges that must be addressed for its successful implementation. One of the primary obstacles is the digital divide, where unequal access to technology and the internet limits some students' ability to fully participate in online learning. Despite the increasing prevalence of digital devices, many students in underserved regions lack the necessary tools, reliable internet connections, or even the

¹ U T Rahmawati and S Suranto, "Menekplorasi Tantangan Dalam Implementasi Pembelajaran Berbasis Proyek Pada Pendidikan Akuntansi Dasar SMK Di Surakarta," *Ideguru: Jurnal Karya Ilmiah Guru* 9, no. 3 (2024): 1208–1217.

² S Zubaidah, "Keterampilan Abad Ke-21: Keterampilan Yang Diajarkan Melalui Pembelajaran," *Seminar Nasional Pendidikan* 2, no. 2 (2016): 1–17.

³ A S Rizal, "Inovasi Pembelajaran Untuk Meningkatkan Hasil Belajar Siswa Di Era Digital," *Attanwir: Jurnal Keislaman Dan Pendidikan* 14, no. 1 (2023): 11–28.

⁴ Mohamad Mustari, *Teknologi Informasi Dan Komunikasi Dalam Manajemen Pendidikan* (Bandung: Gunung Djati Publishing, 2023).

⁵ F Ilmiyatni, "Pengaruh Model Problem Based Learning (PBL) Terhadap Keterampilan Kolaborasi Dan Berpikir Tingkat Tinggi Peserta Didik," 2019.

digital literacy skills required to engage effectively with Online PBL ⁶. This disparity exacerbates educational inequities and undermines the potential of online learning to democratize education.

In addition to technological limitations, Online PBL faces challenges related to student engagement and collaboration in the absence of face-to-face interactions. While traditional PBL encourages in-person communication and teamwork, the online context often creates barriers to building strong interpersonal relationships, which are essential for fostering trust, motivation, and effective teamwork. The lack of direct social interaction may lead to feelings of isolation among students, reducing their motivation and engagement ⁷. Moreover, assessing student performance in online PBL can be complex, as it is difficult to measure the individual contributions of team members, and traditional assessment methods may not effectively capture the collaborative, creative, and problem-solving skills nurtured through this approach ⁸.

Despite these challenges, the advantages of Online PBL are undeniable. This model encourages self-directed learning, critical thinking, and problem-solving skills, which are essential for students to thrive in the digital economy ⁹. Furthermore, Online PBL fosters a more inclusive and diverse learning environment by enabling students from different geographical and cultural backgrounds to collaborate and exchange ideas, thus enriching the learning experience. The use of digital tools and multimedia resources also prepares students for the demands of a digital workplace, where proficiency in these areas is increasingly valued by employers ¹⁰.

This study aims to explore the different models of Online PBL that have been implemented across various educational settings, focusing on how these models have been adapted to the digital context. By reviewing the literature and synthesizing findings from a variety of studies, this paper seeks to provide insights into the benefits and challenges associated with Online PBL. Additionally, it aims to propose recommendations for the successful implementation of Online PBL, with an emphasis on teacher training, technological infrastructure, and curriculum adaptation. Ultimately, this research will contribute to the growing body of knowledge on innovative teaching strategies in the digital era and offer practical guidance for educators and policymakers aiming to optimize the use of Online PBL in educational contexts.

Methods

This study utilizes a qualitative descriptive research design to explore and analyze the implementation of Online Project-Based Learning (PBL) in various educational settings. The qualitative approach is chosen because it allows for a deep, nuanced understanding of the complex

⁶ I Fauziah and R Situmorang, "Pengembangan Modul Hypercontent Untuk Mata Diklat Kode Etik Dan Disiplin Pegawai BPK RI," *Jurnal Pembelajaran Inovatif* 5, no. 2 (2022): 42–49.

⁷ D P Sari, "KETERAMPILAN MENGAJAR GURU ABAD 21," *Analysis* 2, no. 2 (2024): 231–240.

⁸ M P Azisi, M Sulaiman, and M Pd, *E-LEARNING Pembelajaran Digital* (CV. Duta Sains Indonesia, n.d.); Nisaul Barokati Seliro Wangi, M Hafidh Nashrullah, and Muh Barid Nizarudin Wajdi, "Digital Era's Education and Application in Higher Education," *EDUTEC: Journal of Education And Technology* 1, no. 2 (2018): 119–128; Meithiana Indrasari et al., "THE DIGITALIZATION POLICY IN THE EDUCATION SECTOR: INNOVATION AND ADAPTATION," *Journal of Social Political Sciences* 5, no. 3 (2024): 236–251.

⁹ Sari, "KETERAMPILAN MENGAJAR GURU ABAD 21."

¹⁰ Ilmiyatni, "Pengaruh Model Problem Based Learning (PBL) Terhadap Keterampilan Kolaborasi Dan Berpikir Tingkat Tinggi Peserta Didik."

processes involved in Online PBL and its impact on student learning outcomes. A descriptive research design is suitable as it provides a detailed account of the characteristics of Online PBL, identifying its benefits, challenges, and the various models that are being implemented in different educational institutions.

The participants of this research were educators and administrators who have been actively involved in the implementation of Online PBL in their respective educational institutions. A purposive sampling technique was employed to select participants who had substantial experience with Online PBL and could provide valuable insights into its application and outcomes. A total of 30 participants were selected, including primary, secondary, and higher education teachers, who have integrated Online PBL into their teaching practices. These participants were chosen based on their involvement in teaching and managing online PBL projects, ensuring that the data collected would reflect a broad spectrum of experiences across different educational levels.

Data collection in this study was carried out using multiple qualitative methods to ensure a comprehensive understanding of the subject. The following methods were employed:

1. **Semi-structured Interviews:** Interviews were conducted with the selected educators and administrators to gather in-depth, personal accounts of their experiences with Online PBL. The semi-structured interview format allowed for flexibility in exploring the nuances of each participant's experience, while still adhering to a set of core questions designed to cover key themes such as the challenges of implementing Online PBL, student engagement, and assessment methods. The interviews were recorded and transcribed for analysis.
2. **Focus Group Discussions:** In addition to individual interviews, focus group discussions were organized with smaller groups of educators to explore collective insights and perspectives on Online PBL. This method encouraged participants to engage in a dynamic conversation, allowing for the exchange of ideas and experiences. The focus groups were particularly useful in exploring common themes and identifying shared challenges in Online PBL implementation across different educational contexts.
3. **Document Analysis:** To complement the interviews and focus groups, document analysis was conducted on relevant educational documents, such as curriculum plans, course syllabi, and project outlines used in Online PBL. This helped to understand how PBL is structured in the online environment, the integration of technology, and the assessment criteria used for evaluating student performance.

The data collected through interviews, focus groups, and document analysis were analyzed using thematic analysis. This method allowed the researchers to identify patterns and themes across the data and categorize them into broader categories that reflect the main aspects of Online PBL. The process of data analysis followed these steps:

1. **Data Familiarization:** The transcriptions of interviews and focus group discussions were thoroughly read to familiarize the researchers with the content. Initial notes were made to highlight emerging themes and recurring ideas.
2. **Coding:** The data were coded inductively, meaning that codes were developed directly from the data rather than from pre-existing theories. Codes were assigned to segments of text

that related to key aspects of Online PBL, such as collaboration, student engagement, technological tools, and assessment challenges.

3. **Theme Development:** After coding the data, the researchers identified overarching themes that emerged across the various data sources. These themes were then refined and categorized to ensure that they accurately represented the key concepts being explored in the study.
4. **Interpretation and Synthesis:** The final step involved synthesizing the identified themes and interpreting their implications in the context of Online PBL. The researchers compared the findings with existing literature to identify areas of alignment and divergence, as well as to assess the contribution of this study to the broader field of educational research.

Result And Discussion

Result

This section presents the key findings derived from the analysis of the implementation of Online Project-Based Learning (Online PBL) in various educational contexts. The results from the interviews, focus group discussions, and document analysis reveal several critical insights into the models, benefits, challenges, and overall impact of Online PBL on student learning outcomes.

Models of Online Project-Based Learning

The study identified three primary models of Online PBL that have been implemented across educational institutions:

1. **LMS-based Online PBL:** This model involves the use of Learning Management Systems (LMS) such as Moodle, Blackboard, and Canvas to manage project tasks, facilitate student communication, and monitor progress. LMS-based PBL allows educators to structure and organize projects in a digital environment, providing easy access to resources, submission of assignments, and regular feedback. According to the findings, this model was widely adopted in higher education, where students were familiar with digital tools. It was found that this model is effective in ensuring organized and systematic project management, as well as providing students with clear timelines and structured tasks.
2. **Social Media-based Online PBL:** This model incorporates social media platforms such as Facebook, Instagram, and Twitter for project collaboration and communication. Students use these platforms to share ideas, collaborate on tasks, and showcase their final projects. The results showed that the integration of social media provides students with an informal and dynamic space for communication, encouraging creativity and real-time feedback. However, some concerns arose regarding the professionalism and privacy of such platforms, as these tools were often perceived as less formal compared to LMS platforms.
3. **Online Collaboration Tools-based PBL:** The third model utilizes tools like Google Workspace, Microsoft Teams, and Slack for online collaboration. These tools allow students to work together in real time on shared documents, hold virtual meetings, and communicate through instant messaging. The study found that this model was highly

effective in facilitating collaboration, particularly in remote learning contexts where geographical separation posed a challenge. Students in these settings were able to easily collaborate on documents, track each other's progress, and engage in synchronous or asynchronous communication, which supported effective teamwork and knowledge sharing.

Benefits of Online PBL

The analysis revealed several key benefits of implementing Online PBL, particularly in the development of essential 21st-century skills:

1. **Enhanced Collaboration:** One of the main benefits of Online PBL is the development of collaborative skills. The results showed that students who participated in Online PBL demonstrated significant improvements in teamwork, communication, and coordination. Students were able to work together effectively, even when geographically dispersed, and were able to manage projects efficiently using digital collaboration tools. This model helped students develop skills that are crucial in today's increasingly digital and globalized workforce.
2. **Critical Thinking and Problem-Solving:** Online PBL encourages students to engage with real-world problems, which in turn fosters critical thinking and problem-solving skills. The study found that students were more likely to approach problems creatively, analyze data, and work collaboratively to come up with solutions. Through the process of working on complex projects, students were challenged to think critically and apply their knowledge in practical situations, leading to deeper understanding and skill development.
3. **Digital Literacy:** The use of digital tools and platforms in Online PBL enabled students to develop digital literacy skills, which are essential in the modern workplace. Students became proficient in using tools such as Google Docs, Microsoft Teams, and cloud-based platforms, gaining hands-on experience that will be valuable in future careers. This aspect of Online PBL was particularly highlighted by the participants, who reported significant improvements in their digital competencies.
4. **Personalized Learning:** Online PBL also provides an opportunity for personalized learning, where students can engage with content at their own pace and according to their preferred learning styles. The flexibility of online platforms allows students to choose how they approach tasks and projects, providing a more tailored learning experience. This was particularly beneficial for students who might have struggled with the rigid timelines and structures of traditional classroom learning.

Challenges of Online PBL

The study also identified several challenges associated with the implementation of Online PBL:

1. **Limited Access to Technology:** One of the most significant challenges reported by participants was the digital divide, where students had limited access to the necessary technology or reliable internet connections to engage fully in Online PBL. This issue was

particularly prevalent in low-income regions and among students from disadvantaged backgrounds. The lack of access to devices, as well as unreliable or slow internet connections, hindered the ability of some students to participate in collaborative activities or complete projects on time.

2. **Lack of Face-to-Face Interaction:** Another challenge identified in the study was the absence of face-to-face interaction, which affected the social dynamics of project collaboration. Many students reported feelings of isolation and disconnectedness, which led to decreased motivation and engagement. The lack of in-person communication made it difficult for students to build strong relationships with their peers and instructors, which is often essential for effective collaboration and engagement in traditional PBL environments.
3. **Assessment Challenges:** The study also found that assessing student performance in Online PBL posed significant challenges. Traditional assessment methods, such as exams and quizzes, were not sufficient to evaluate the collaborative, creative, and problem-solving skills fostered through PBL. Educators reported difficulty in assessing the individual contributions of students in group projects, and there was a lack of standardized methods for measuring outcomes in Online PBL settings. This led to concerns about the fairness and reliability of assessments.
4. **Teacher Preparedness and Training:** A recurring challenge highlighted by educators was the need for adequate training and professional development in using digital tools for Online PBL. Many teachers reported a lack of familiarity with the technologies required to facilitate online projects effectively, which hindered the smooth implementation of Online PBL. As a result, educators expressed the need for ongoing training programs to develop their technological competencies and pedagogical strategies for online teaching.

Discussion

The results of this study highlight several significant insights regarding the implementation of Online Project-Based Learning (Online PBL) in various educational contexts. This section discusses the implications of these findings, comparing them with existing literature and identifying the potential contributions of Online PBL to modern educational practices.

Effectiveness of Different Online PBL Models

The study revealed that LMS-based Online PBL, social media-based PBL, and PBL using online collaboration tools all serve as viable models for enhancing student learning. However, each model presents unique advantages and challenges, which need to be considered when selecting the appropriate approach for a particular educational context.

1. **LMS-based Online PBL** was found to be highly effective in structured learning environments, particularly in higher education. The use of platforms such as Moodle and Blackboard allowed for organized project management, facilitating easy communication between students and instructors. This model aligns with previous research that has shown

LMS platforms to be effective tools for course management and feedback ¹¹. The ability to monitor progress, offer timely feedback, and manage project timelines made this model an attractive choice for institutions that require a systematic approach to online learning. However, as reported by participants, the rigidity of LMS-based systems may hinder creativity and flexibility, as students may feel constrained by the platform's limitations.

2. Social media-based PBL introduced an informal, dynamic approach to collaboration, with students engaging with platforms like Facebook and Instagram to communicate and share ideas. While previous studies have highlighted the benefits of social media in fostering informal learning and creativity ¹², the results of this study indicated that the lack of professional boundaries and potential privacy concerns were significant drawbacks. Although students reported enjoying the flexibility and instant feedback that social media platforms offer, concerns about privacy and the informal nature of interactions on these platforms must be addressed. Future research should investigate how to balance the informal engagement offered by social media with the professionalism required in academic contexts.
3. Online collaboration tools such as Google Workspace and Microsoft Teams proved to be highly effective for remote collaboration, allowing students to work on shared documents, communicate in real-time, and conduct virtual meetings. This model aligns with findings from earlier research, which emphasized the benefits of digital collaboration tools in enhancing communication and teamwork among geographically dispersed students (Mustari, 2023). The flexibility offered by these tools makes them ideal for fostering global collaboration and cross-cultural learning. However, participants in this study noted challenges related to the technical complexity of some collaboration tools, particularly for students who are less familiar with digital platforms.

Benefits of Online PBL

The benefits of Online PBL were clearly evident in the findings, particularly in the areas of collaboration, critical thinking, and digital literacy. These findings align with existing research that emphasizes the importance of collaborative learning and the development of 21st-century skills ¹³.

1. Collaboration emerged as one of the primary benefits of Online PBL. The study found that students were able to develop strong teamwork skills by working together on projects, regardless of their physical location. This is consistent with previous studies that have shown that PBL, especially in online settings, fosters teamwork and communication skills

¹¹ M R Fahlevi, "Kajian Project Based Blended Learning Sebagai Model Pembelajaran Pasca Pandemi Dan Bentuk Implementasi Kurikulum Merdeka," *Sustainable Jurnal Kajian Mutu Pendidikan* 5, no. 2 (2022): 230–249; Elisabeth MCGEE and Prerna POOJARY, "EXPLORING BLENDED LEARNING RELATIONSHIPS IN HIGHER EDUCATION USING A SYSTEMS-BASED FRAMEWORK," *Turkish Online Journal of Distance Education* (2020): 1–13, <http://dx.doi.org/10.17718/tojde.803343>.

¹² M Salimi-Thursday and E Rosita-Friday, *Pengelolaan Kelas Digital*, n.d.

¹³ Zubaidah, "Keterampilan Abad Ke-21: Keterampilan Yang Diajarkan Melalui Pembelajaran"; Ilmiyatni, "Pengaruh Model Problem Based Learning (PBL) Terhadap Keterampilan Kolaborasi Dan Berpikir Tingkat Tinggi Peserta Didik."

- essential for success in the modern workplace (Azisi et al., n.d.). The ability to collaborate effectively in virtual teams has become a crucial skill in today's digital and globalized world.
2. Critical thinking was another significant outcome of Online PBL. Students who participated in Online PBL were required to engage with real-world problems, which pushed them to think critically and creatively. This finding aligns with the work of Rahmawati & Suranto ¹⁴, who found that PBL encourages problem-solving and analytical thinking. The study's findings suggest that Online PBL provides an ideal environment for cultivating these skills, which are crucial for students' personal and professional development.
 3. Digital literacy was also a major benefit of Online PBL, with students gaining proficiency in various digital tools and platforms. The results demonstrated that students who participated in Online PBL developed greater technological competence, which will be essential in their future careers. As the workforce becomes increasingly dependent on digital tools, the ability to navigate and use these tools effectively has become an essential skill. This finding is consistent with previous research highlighting the importance of digital literacy in education ¹⁵.

Challenges of Online PBL

Despite the advantages, the implementation of Online PBL also presents several challenges that need to be addressed to ensure its success. The study identified limited access to technology, lack of face-to-face interaction, and assessment difficulties as the primary obstacles faced by both educators and students.

1. Limited access to technology was the most significant challenge reported by participants. Many students, particularly those from disadvantaged backgrounds, lacked access to the necessary devices or reliable internet connections to fully participate in Online PBL. This finding is consistent with the digital divide identified in previous studies, which highlights the inequities in access to technology and the internet in educational contexts ¹⁶. To address this challenge, educational institutions must invest in infrastructure and provide students with the resources they need to participate in online learning effectively.
2. The lack of face-to-face interaction in Online PBL environments was another challenge that impacted student engagement. Students reported feelings of isolation, which affected their motivation and collaboration. While some studies have found that Online PBL can encourage meaningful collaboration, this study highlights the importance of social presence and community building in online learning environments ¹⁷. Educators must

¹⁴ Rahmawati and Suranto, "Mengeksplorasi Tantangan Dalam Implementasi Pembelajaran Berbasis Proyek Pada Pendidikan Akuntansi Dasar SMK Di Surakarta."

¹⁵ Sari, "KETERAMPILAN MENGAJAR GURU ABAD 21."

¹⁶ Fauziah and Situmorang, "Pengembangan Modul Hypercontent Untuk Mata Diklat Kode Etik Dan Disiplin Pegawai BPK RI."

¹⁷ Sari, "KETERAMPILAN MENGAJAR GURU ABAD 21"; S Hartik, S Utaminingsih, and A H Madjdi, "A Need Assessment of Integrated Science Teaching Material Based Higher Order Thinking Skills (HOTS)," in *Journal of Physics: Conference Series*, ed. Sari M.W., vol. 1823 (Masters of Elementary Education Study Program, Faculty of Teacher Training and Education, Universitas Muria Kudus, Indonesia: IOP Publishing Ltd, 2021),

explore ways to foster a sense of community and engagement, even in virtual spaces, to mitigate the potential negative effects of isolation.

3. Assessment and evaluation in Online PBL presented significant challenges, particularly when it came to measuring individual contributions in group projects. The study found that traditional assessment methods, such as exams, were inadequate in capturing the collaborative and problem-solving skills fostered through PBL¹⁸. This finding supports the need for the development of alternative assessment models that can better evaluate teamwork, critical thinking, and digital literacy in the context of Online PBL. Educators must explore innovative approaches to assessment, such as peer evaluations and self-assessments, to ensure that students' contributions to group projects are fairly evaluated.

The findings from this study suggest that while Online PBL holds significant potential for enhancing student engagement, collaboration, and skill development, it is essential to address the challenges of technology access, social interaction, and assessment. By investing in technological infrastructure, promoting teacher training, and developing new assessment frameworks, institutions can optimize the effectiveness of Online PBL. Future research should focus on exploring long-term impacts of Online PBL on student outcomes, particularly in diverse educational settings, and evaluate the effectiveness of hybrid models that combine online and face-to-face learning experiences.

Conclusion

This study has explored the implementation of Online Project-Based Learning (Online PBL) in various educational settings, revealing valuable insights into its effectiveness, benefits, challenges, and overall impact on student learning. The research highlights the adaptability of Online PBL across different educational levels and contexts, demonstrating its potential to foster critical 21st-century skills such as collaboration, critical thinking, and digital literacy. By examining three primary models of Online PBL—LMS-based PBL, social media-based PBL, and PBL using online collaboration tools—the study has provided a comprehensive understanding of how each model functions within the digital learning environment.

The findings confirm that LMS-based PBL offers a structured and organized approach to project management, making it highly suitable for higher education settings. It provides educators with a clear framework for monitoring progress and delivering feedback. Social media-based PBL, on the other hand, introduces an informal, dynamic space for collaboration, fostering creativity

<https://www.scopus.com/inward/record.uri?eid=2-s2.0-85103840418&doi=10.1088%2F1742-6596%2F1823%2F1%2F012078&partnerID=40&md5=7828df7c7f6ddfb30772e611863c6e20>.

¹⁸ Ahmed Elzainy, Abir El Sadik, and Waleed Al Abdulmonem, "Experience of E-Learning and Online Assessment during the COVID-19 Pandemic at the College of Medicine, Qassim University," *Journal of Taibah University Medical Sciences* 15, no. 6 (December 2020): 456–462, <https://pubmed.ncbi.nlm.nih.gov/33106752/>; R A A Rahim, S Man, and L H Abdullah, "Transformation of Shariah Studies in Malaysian Higher Learning Institution," *Middle East Journal of Scientific Research* 12, no. 2 (2012): 145–154, <https://www.scopus.com/inward/record.uri?eid=2-s2.0-84870769124&doi=10.5829%2Fidosi.mejsr.2012.12.2.1678&partnerID=40&md5=2df8f91592128f7cbf2cdecfe4859f70>.

and real-time interaction. However, privacy concerns and the professional use of social media platforms remain significant challenges. PBL using online collaboration tools such as Google Workspace and Microsoft Teams emerged as a flexible model that allows students to collaborate efficiently, even when geographically dispersed. This model is particularly effective in facilitating remote learning and global collaboration, though it requires sufficient digital literacy to navigate the tools effectively.

One of the key benefits of Online PBL identified in this study is its ability to enhance collaboration among students. Regardless of physical distance, students were able to work together effectively, sharing ideas and managing projects using various digital tools. This is consistent with previous research that has emphasized the importance of teamwork and communication skills in the 21st-century workforce. Furthermore, Online PBL encouraged critical thinking and problem-solving, as students were challenged to engage with real-world problems, analyze data, and develop creative solutions. The study also found that Online PBL provided opportunities for personalized learning, allowing students to progress at their own pace and choose their preferred modes of engagement, which significantly enhanced student motivation and engagement.

However, the implementation of Online PBL is not without its challenges. Limited access to technology was a significant barrier for some students, especially those in underserved and low-income regions. Despite the growing availability of digital devices, many students still lack access to reliable internet connections, which restricts their ability to fully participate in Online PBL. Additionally, the absence of face-to-face interaction in Online PBL environments created feelings of isolation among students, reducing motivation and engagement in some cases. This highlights the importance of maintaining social presence in online learning environments to foster a sense of community and connection. Moreover, the study identified challenges in assessing student performance in Online PBL, particularly in group projects. Traditional assessment methods, such as exams, were found to be insufficient in capturing the collaborative, creative, and problem-solving skills nurtured through PBL. There is a clear need for the development of alternative assessment models that can more effectively evaluate teamwork, digital literacy, and critical thinking.

The findings of this study have significant implications for educators, institutions, and policymakers. To optimize the effectiveness of Online PBL, institutions must invest in technological infrastructure to ensure that all students have access to the necessary devices and stable internet connections. Furthermore, there is a need for comprehensive teacher training programs to equip educators with the skills required to effectively facilitate Online PBL. Educators must also be supported in developing digital literacy skills to navigate and use the various tools and platforms essential for Online PBL. Additionally, institutions must consider curriculum adjustments to ensure that Online PBL is integrated seamlessly into existing educational frameworks, with clear learning objectives and effective assessment strategies.

Online PBL offers an innovative and effective approach to education that can help address the challenges of traditional classroom learning in the digital era. While it presents several challenges, particularly related to technology access and student engagement, the potential benefits of Online PBL in developing critical skills for the 21st century make it a valuable pedagogical

model. With proper planning, training, and infrastructure, Online PBL has the potential to revolutionize education by making learning more flexible, accessible, and collaborative. Future research should focus on exploring the long-term impacts of Online PBL on student outcomes, particularly in diverse educational contexts, and evaluate the effectiveness of hybrid models that combine online and face-to-face learning experiences.

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