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Preliminary Study: Project-Based Learning with Chamilo e-learning in Junior High School Physics Education

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Abstract

Implementing Project-Based Learning (PjBL) is an effective strategy for enhancing 21st-century skills. Integrating technology through Chamilo e-learning facilitates more interactive and engaging digital learning. This study aims to analyze the implementation of the Chamilo e-learning-assisted PjBL model in schools and assess teachers' and students' confidence in its application. This research employs a survey method with random sampling involving five science teachers and 60 students. Data were collected through a questionnaire validated for reliability (KR-20 coefficient: 0.82 for teachers, 0.77 for students), covering three key aspects: (1) PjBL implementation in schools, (2) Chamilo e-learning utilization, and (3) the effectiveness of Chamilo e-learning-assisted PjBL in enhancing students' creative thinking and digital literacy. Data analysis was conducted using a descriptive quantitative approach by calculating percentages for each measured aspect. The findings indicate that the Chamilo e-learning-assisted PjBL model is rarely implemented in schools. Most teachers have not applied this model to enhance students' creative thinking and digital literacy due to their limited understanding of PjBL and Chamilo e-learning. Furthermore, 100% of students reported never having learned using this model. The confidence level of teachers regarding the need for implementing Chamilo e-learning-assisted PjBL reached 80%, while students' confidence level was 88.5%. These results highlight the urgent need for systematic interventions to enhance the application of Chamilo e-learning-assisted PjBL in science education. This study suggests continuous teacher training to improve their competency in utilizing this model. Moreover, schools must ensure sufficient technological infrastructure and stable internet access to support its effective implementation, ultimately fostering students' creative thinking and digital literacy skills.

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INTRODUCTION

Modern education demands that students acquire skills relevant to the rapidly evolving global landscape. In the digital era, 21st-century skills are essential as they are interdisciplinary and multidimensional (Cristea et al., 2024; Maulidia et al., 2023). The government has introduced various policies to address these challenges, including the *Merdeka Curriculum*, which emphasizes active learning approaches (Niyarci et al., 2022; Rahayu et al., 2022). One instructional model that aligns with this approach is Project-Based Learning (PjBL), particularly in secondary science education. PjBL provides a more

active and contextual learning experience, enhancing students' engagement and understanding of scientific concepts. However, the implementation of this model faces challenges, especially when integrated with e-learning platforms such as Chamilo e-learning (Nasir et al., 2023; Puri et al., 2024; Rehman et al., 2024; Tsybulsky & Muchnik-Rozanov, 2021).

The primary challenges in implementing Chamilo e-learning-assisted PjBL stem from two key aspects: student difficulties and teacher constraints. From the students' perspective, lack of motivation and interest in science subjects is a significant obstacle (Gea & Zega, 2023; Yunarti, 2021). Many students perceive the material as irrelevant to their daily lives, leading to disengagement in learning. Additionally, difficulties in understanding scientific concepts are exacerbated when students are required to apply them in e-learning-based projects (Laksono et al., 2023; Suana et al., 2023). Variations in access to technology further hinder student participation in digital learning. Not all students possess adequate digital skills to navigate e-learning platforms effectively, making time management and project collaboration more challenging (Putri et al., 2024; Sinambela et al., 2024). These barriers must be addressed to improve the quality of education, aligning with Government Regulation No. 32 of 2013 on National Education Standards.

On the other hand, teachers also face challenges in designing and managing project-based learning integrated with Chamilo e-learning. Educators must develop projects aligned with the curriculum while ensuring they are engaging for students, which requires a deep understanding of scientific content and innovative teaching strategies (Fransiska & Ain, 2022; Puri et al., 2024). Additionally, limited technological proficiency among teachers poses a barrier to optimizing e-learning platforms. Teachers need adequate training to effectively integrate technology into their teaching practices (Fernández-Morante et al., 2023; Momdjian et al., 2024). Without proper technological support, the effectiveness of PjBL in enhancing student learning outcomes cannot be maximized.

Beyond instructional challenges, assessment in PjBL is also a complex aspect. Unlike traditional methods that primarily rely on written tests, PjBL requires an assessment approach that evaluates both the process and the final project outcomes. Teachers must assess various competencies, including critical thinking, creativity, and student's ability to collaborate in completing projects (Nadlir et al., 2024; Seevaratnam et al., 2023). Nevertheless, PjBL offers numerous benefits for students. This model not only enhances critical thinking and collaborative skills but also allows students to apply their knowledge in real-world contexts, making it highly relevant for science education (Azzahra et al., 2023; Hsu & Tsai, 2022; Mahombari et al., 2023; Misbah et al., 2024; Sinaga et al., 2023; Wati et al., 2024). Students can explore their interests and boost their learning motivation by actively engaging in projects.

The integration of Chamilo e-learning into PjBL provides flexibility in learning. This platform offers various features, such as discussion forums, virtual classrooms, and resource storage, enabling students to learn independently and collaboratively (Chasani & Sari, 2023; Tiari et al., 2020). When effectively utilized, Chamilo can enhance the efficiency of PjBL by facilitating interactions between students and teachers while encouraging deeper exploration of scientific concepts. However, the success of Chamilo's implementation largely depends on the readiness of both students and teachers to use it optimally (Rochim et al., 2021; Tseng, 2020). Therefore, further research is needed to examine how the integration of Chamilo in PjBL can support the development of 21st-century skills, particularly creative thinking and digital literacy among students.

Several studies indicate that Indonesian students' creative thinking and digital literacy skills remain low (Qomariyah & Subekti, 2021; Tazun & Fransiska, 2022; Utomo et al., 2024). Conventional teaching approaches often fail to encourage students to think

creatively or utilize technology effectively in learning. PjBL has the potential to address these issues by providing opportunities for students to engage in innovative thinking and develop solutions for real-world problems presented in their projects (Sa'adah & Pertiwi, 2022; Yuniar et al., 2023). In digital literacy, students must also develop the ability to search for, evaluate, and process digital information effectively, particularly in today's information-driven era (Noor et al., 2017; Zaharah & Silitonga, 2023). However, challenges related to access and utilization of technology continue to hinder the development of these skills, especially for students in regions with limited digital infrastructure (Putri et al., 2024; Subroto et al., 2023).

Based on the discussion above, this study aims to explore how implementing the Chamilo e-learning-assisted PjBL model can improve student learning outcomes in science education. Specifically, this study has two main objectives: (1) To analyze the implementation of the Chamilo e-learning-assisted PjBL model in schools and (2) To examine the needs of teachers and students in implementing the Chamilo e-learning-assisted PjBL model.

The novelty of this study lies in integrating Chamilo e-learning with the PjBL model, which has been rarely explored in science education. While several studies have highlighted Chamilo's advantages over other Learning Management Systems (LMS), particularly its innovative features that support science education and its broad accessibility at no cost (Getenet et al., 2024; Mrani et al., 2023; Vukic et al., 2020), further investigation is needed. Therefore, the findings of this study are expected to contribute to developing more effective and innovative instructional strategies for science education in Indonesia.

METHOD

This study employs a survey research design with a descriptive quantitative approach. Data were collected through the distribution of questionnaires to 5 science teachers and 60 students in schools. The sample was selected using a random sampling technique. The research instrument consisted of teacher and student needs questionnaires regarding implementing the PjBL model assisted by Chamilo e-learning to enhance student's creative thinking and digital literacy skills. The teacher questionnaire comprised 30 items, while the student questionnaire consisted of 23 items.

The instrument covered three main aspects: (1) the implementation of the PjBL model in schools, (2) the utilization of Chamilo e-learning in schools, and (3) the integration of the Chamilo e-learning-assisted PjBL model to enhance students' creative thinking and digital literacy. The research instrument was tested for validity and reliability to ensure its credibility as a data collection tool. Reliability testing using the KR-20 coefficient indicated that the teacher needs questionnaire had a reliability score of 0.82, while the student needs questionnaire had a reliability score of 0.77, demonstrating a good level of reliability.

The collected data were analyzed using descriptive statistical techniques, including percentage calculations, to identify patterns of needs and confidence levels in implementing this learning model. Table 1 presents the detailed categorization of the needs analysis used in this study.

Table1 Needs analysis categorization

No.	Percentage	Category
1.	88<N≤100	Very High
2.	76<N≤88	High
3.	65<N≤76	Quite High
4.	<65	Low

(Rochim et al., 2021)

RESULTS AND DISCUSSION

A preliminary study was conducted to identify and provide an overview of teachers' and students' knowledge regarding the need for using Chamilo e-learning based on Project-Based Learning, as well as an overview of students' digital literacy and creative thinking skills from both teachers' and students' perspectives. The results of the questionnaires distributed to science teachers and students revealed some initial insights. Table 2 presents the results of the needs analysis questionnaire on implementing the Project-Based Learning model supported by Chamilo e-learning from the teachers' perspective.

Table 2 Results of the needs analysis questionnaire on the implementation of the project-based learning model supported by Chamilo e-learning from the teachers' perspective

No.	Question	Teachers' Responses
1.	What teaching methods do you often use to deliver science lessons in class?	The frequently used methods include lectures, question-and-answer sessions, and discussions.
2.	Have you ever heard of or used Project-Based Learning (PjBL) in science teaching?	Most teachers responded that they have heard of PjBL but rarely use it. Others have heard of it but have never implemented it in their teaching.
3.	What challenges do you face when implementing Project-Based Learning (PjBL) in science education?	70% of teachers reported lacking confidence in managing a project-based classroom, 60% cited time constraints, and 40% highlighted the lack of supporting resources.
4.	Have you ever used e-learning as a teaching medium for science?	80% of teachers responded that they rarely use e-learning in teaching, while the remaining respondents stated that they had never used e-learning in their instruction.
5.	What challenges do you face when implementing e-learning-based teaching?	60% of teachers felt they were not sufficiently skilled in using e-learning platforms.
6.	Have you ever heard of or utilized Chamilo e-learning as a medium for teaching?	100% of teachers responded that they had never heard of or used Chamilo e-learning.
7.	In your opinion, have students demonstrated creative thinking skills in science learning?	All teacher respondents stated that 60% of students rarely demonstrated creative thinking skills in science learning.
8.	What do you think are the reasons students have not yet achieved creative thinking skills?	Teachers identified the following issues: 57.4% of students perceived science as difficult, students were not actively seeking answers to scientific problems independently, and students believed that science was not essential in their daily lives.
9.	How would you assess students' digital literacy?	Most teacher respondents indicated that 88.5% of students had poor digital literacy skills, while a smaller portion of teachers noted that only 11.5% of students demonstrated adequate digital literacy.
10.	What are the challenges students face in digital learning?	Teachers identified issues such as a lack of digital literacy knowledge, low awareness and motivation, limited facilities and support, and cultural habits.
11.	Do you think implementing the PjBL model supported by Chamilo can improve students' creative thinking skills and digital literacy?	All respondents expressed positive views, stating that implementing the PjBL model supported by Chamilo can enhance students' creative thinking skills and digital literacy.

Table 3 presents the results of the needs analysis questionnaire on the implementation of the PjBL model supported by Chamilo e-learning from the students' perspective.

Table 3 Results of the needs analysis questionnaire on the implementation of the project-based learning model supported by Chamilo e-learning from the student's perspective

No.	Question	Students' Responses
1.	Based on your experience, what teaching method is most frequently used by your science teacher at school?	Most students answered that the most commonly used methods are discussion, followed by assignments, explanations, and presentations.
2.	Have you ever used e-learning as a medium for learning science?	All students responded that they had never used e-learning.
3.	Have you ever learned science through projects that you can apply in everyday life?	Most students responded that they have never learned through projects, while some stated that they have encountered such methods a few times.
4.	Have you ever studied using Chamilo e-learning as a learning medium?	All students responded that they had never used Chamilo e-learning.
5.	Have you ever learned using projects and Chamilo e-learning?	All students responded that they had never used Project and Chamilo e-learning.
6.	What challenges do you face in learning science materials?	Students mentioned several challenges, including difficult-to-understand materials, lack of teaching aids, disinterest in science, difficulty memorizing content, and incompatibility with the teacher's teaching style.
7.	Are you interested in learning science using digital technology?	All students responded positively and agreed.
8.	Are you interested in learning through projects and using Chamilo e-learning in science learning?	All students responded positively and agreed.

The findings in Table 2, particularly questions 1 and 2, reveal teachers' responses to implementing the PjBL model in schools. Most teachers reported that they rarely heard of or used the PjBL-based learning approach, while others stated that they frequently encountered or employed it. However, further inquiry revealed that although the term PjBL is relatively well-known, its implementation in classrooms remains infrequent. This can be attributed to the fact that many teachers possess only a basic understanding of PjBL but lack confidence in applying it effectively.

Previous studies indicate that teachers' lack of confidence in implementing PjBL stems from insufficient training and limited participation in programs integrating PjBL into teaching (Puri et al., 2024; Yusriani et al., 2020). Data from this survey show that 70% of teachers feel unconfident in managing a project-based classroom due to their limited training. Teachers' perspectives and readiness to implement PjBL significantly influence student learning outcomes (Haatainen & Aksela, 2021; Rochim et al., 2021). Therefore, enhancing teachers' competencies through intensive training and mentorship in PjBL implementation is crucial.

Another factor contributing to the low integration of PjBL is the limited time available to cover all required materials and the need for tools and resources that may not always be accessible. Several studies indicate that PjBL often takes longer than conventional teaching methods, leading teachers to feel burdened by curriculum demands and tight schedules (Fransiska & Ain, 2022; Zuhdiyyah et al., 2023). In this survey, 60% of teachers identified time constraints as the primary barrier to implementing PjBL, while 40% cited a lack of resources. To address these issues, schools should provide solutions such as training in time

management for PjBL and developing projects utilizing readily available resources that do not require expensive equipment, such as repurposed materials or natural objects (Nadlir et al., 2024; Wardhan et al., 2023).

Regarding the use of digital media in teaching (questions 3-5), the findings indicate that only 20% of teachers actively incorporate digital media in their instruction, whereas 80% rarely or never use it. This limited utilization of digital media inevitably affects students' digital literacy. Other research also highlights the low adoption of digital media in education due to the lack of teacher training on integrating technology into the classroom (Muhaimin et al., 2020; Tanggur, 2022). Without effective training, teachers feel unprepared to adopt technology in their teaching practices. This is supported by data showing that 60% of teachers consider themselves insufficiently skilled in using digital learning platforms. Additionally, restricted access to devices and unstable internet connections pose significant obstacles to the effective use of digital tools in classrooms (Kholid, 2020; Pribadi et al., 2023).

In the 21st century, technology-enhanced learning is essential for improving students' skills and academic outcomes (Ahyani et al., 2024; Cristea et al., 2024; Hammoda & Foli, 2024). However, according to the results of the questionnaire, 100% of teachers and students had never heard of or used Chamilo e-learning in their educational activities. Chamilo is an open-source LMS platform that provides collaborative and online learning features (Chasani & Sari, 2023; Wati et al., 2022). Research indicates that Chamilo can help structure learning materials and assignments more effectively, with studies reporting an improvement in students' learning competence, achieving a gain value of 0.70 in the high category (Tiari et al., 2020; Yulita et al., 2018). Thus, introducing and training teachers to use Chamilo is essential for enhancing the effectiveness of technology-integrated education.

Regarding questions 6 to 10, the findings indicate that students still exhibit relatively low creative thinking skills. A significant proportion of teachers (60%) reported that students are passive in seeking answers to science-related problems presented by their teachers. Instead, students rely solely on teacher-provided information without attempting to find solutions independently (Fakhirah et al., 2023; Safarati et al., 2024). Furthermore, it was found that 57.4% of students perceive science subjects as difficult and irrelevant to daily life, which negatively impacts their creative thinking abilities (Purwanti et al., 2024; Qomariyah & Subekti, 2021).

Similarly, students' digital literacy remains low. In this survey, only 11.5% of students demonstrated the ability to distinguish information from credible sources, while 88.5% struggled to assess the reliability of online information. Several factors contributing to students' low digital literacy include a lack of knowledge about digital literacy, limited awareness and motivation, insufficient facilities, and cultural and habitual influences. Additional research corroborates this, showing that students' digital literacy scores reached only 32.81, falling into the very poor category (Pratama et al., 2019; Tazun & Fransiska, 2022).

From the students' perspective (Table 3), teachers' most commonly introduced teaching methods include discussions, assignments, lectures, and presentations, while project-based science learning remains rare. Additionally, digital integration in science instruction is still suboptimal, as evidenced by the limited use of e-learning platforms such as Chamilo. Therefore, adopting technology-integrated project-based science learning can serve as a solution to various challenges students face in learning science, particularly in enhancing their creative thinking skills and digital literacy (Chen et al., 2022; Laksono et al., 2023; Noor et al., 2017; Yu, 2024).

Figure 1 illustrates the confidence level among teachers and students regarding the need to implement the Project-Based Learning model using Chamilo e-learning.

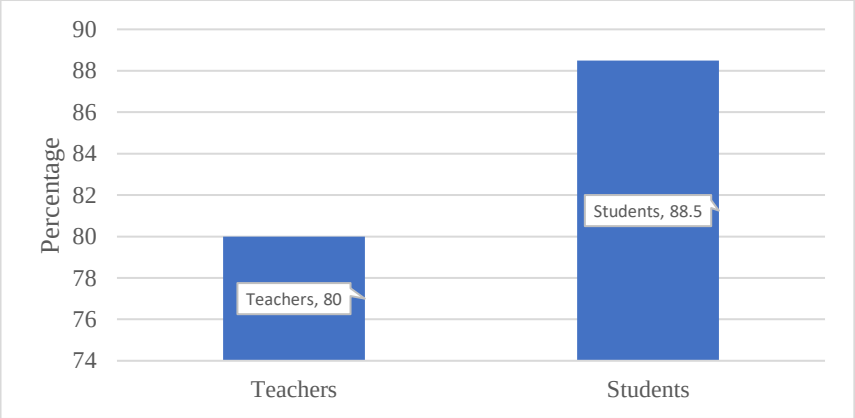

Figure 1 Confidence levels of teachers and students regarding the need for implementation

Based on Figure 1, it is evident that the confidence levels of both teachers and students fall into the high category. This indicates that respondents positively perceive the potential to enhance students' creative thinking skills and digital literacy through implementing the Project-Based Learning model assisted by Chamilo e-learning. This finding aligns with the studies conducted by (Riyasni et al., 2023; Rochim et al., 2021), emphasizing the importance of effective teaching methods in improving students' understanding of fundamental learning concepts and other higher-order thinking skills.

This study also highlights that trust in learning tools from the perspectives of teachers and students is a crucial factor in successfully implementing project-based learning models. Additionally, similar studies indicate that teachers and students require the PjBL model to enhance creative thinking skills and need digital tools such as Chamilo to support the development of digital-based learning (Nurkhofifah et al., 2022; Yanti & Novaliyosi, 2023; You, 2021). Therefore, the findings of this study demonstrate that both teachers and students view the Project-Based Learning model assisted by Chamilo e-learning as an essential instrument for improving students' creative thinking abilities and digital literacy.

Nevertheless, this study has several limitations that should be considered for future research. One of the main limitations is the lack of an in-depth analysis of the technical and pedagogical challenges encountered in implementing Chamilo e-learning within the PjBL model. Factors such as the readiness of technological infrastructure in schools, the digital competence of teachers and students, and the availability of supporting resources have not been thoroughly explored. Furthermore, this study does not comprehensively discuss the long-term impact of implementing this model on students' learning outcomes.

Several concrete strategies can be recommended to address the challenges of implementing this model. First, continuous teacher training is essential to enhance their skills in integrating digital technology into project-based learning. Second, developing Chamilo-based learning modules aligned with curriculum needs could facilitate the implementation of this model across various schools. Third, schools must ensure the readiness of technological infrastructure, including the availability of devices and stable internet access, to enable all students to participate effectively in digital-based learning. Fourth, collaboration between schools, the government, and e-learning platform providers should be strengthened to provide ongoing technical and pedagogical support. By considering these recommendations, implementing the PjBL model assisted by Chamilo e-learning is expected to be more effective and provide maximum benefits for developing students' 21st-century skills.

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CONCLUSION

Based on the findings presented, the implementation of the PjBL model supported by Chamilo e-learning in science education is still very limited in schools. The needs analysis indicates that teachers and students strongly agree with and provide positive responses to adopting the PjBL model supported by Chamilo e-learning. These findings suggest that teachers and students require effective learning models and media to enhance students' creative thinking skills and digital literacy. The confidence level in implementing the PjBL model using Chamilo e-learning is 80% among teachers and 88.5% among students. Therefore, efforts are needed to improve these skills by integrating the PjBL model with Chamilo e-learning into science education.

The implications of this study indicate that integrating the PjBL model with Chamilo e-learning can enhance students' creative thinking and digital literacy, particularly in science education. Therefore, developing a curriculum that integrates PjBL and technology is essential. This study also highlights the importance of teacher training and the provision of adequate technological infrastructure to support the implementation of this learning model. However, this study has limitations in terms of the number of respondents and the schools that were the focus of the research. Further research with a larger sample and more varied methodologies will help enrich these findings.

This research's main contribution to the field of physics education is providing insights into how the PjBL model supported by Chamilo e-learning can be effectively implemented to enhance students' creative thinking skills and digital literacy in understanding physics concepts. Through a project-based approach supported by technology, students can actively explore and connect physics concepts with real-life applications, making learning more contextual and meaningful. Additionally, this study serves as a foundation for developing innovative technology-based learning strategies in physics education, aligning with the demands of 21st-century learning.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

The contributions of each author are as follows: Conceptualization, SI and MR; methodology, YY; data collector, SI and YY; formal analysis, SI and YY; writing-preparation of the original draft, SI and MR.; and reference collection, SI and MR.

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