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Technology Integration by Teachers through Moodle to Support Self-Regulated Learning in Project-Based Learning

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Abstract

Background of study: The development of educational technology encourages the use of the Learning Management System (LMS) as a means of supporting innovative learning. Moodle, as a widely used LMS, has the potential to be integrated with Project-Based Learning (PjBL) to create student-centered learning while supporting the development of self-regulated learning.

Aims: This article systematically examines how teachers integrate Moodle into the implementation of PjBL and its role in supporting students' self-regulated learning. The study focused on the form of Moodle integration, the use of Moodle features, and its impact on self-regulation, engagement, and student learning outcomes.

Methods: This study uses the Systematic Literature Review (SLR) approach and follows the PRISMA guidelines. Articles are obtained from the Google Scholar database through the Publish or Perish application with a publication range of 2017–2025. The selection process was carried out through the identification, screening, feasibility assessment, and inclusion stages, resulting in 26 articles that were analyzed and synthesized thematically.

Result: The results of the synthesis show that the integration of Moodle in PjBL is carried out through the design of project assignments, management of project stages, facilitation of group collaboration, and monitoring of student learning progress. Moodle features such as assignments, discussion forums, resources, and calendars play an important role in supporting student learning, planning, monitoring, and reflection. In general, the integration has a positive impact on improving self-regulated learning, active engagement, responsibility, and the quality of student project results.

Conclusion: The integration of Moodle by teachers in Project-Based Learning not only serves as a technical support for learning, but also as a learning environment that encourages students' self-regulation. These findings confirm the importance of teachers' pedagogical roles in optimizing Moodle to create meaningful and sustainable project-based learning.

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INTRODUCTION

The development of digital technology in education encourages the use of *Learning Management System* (LMS) as a means of supporting learning that is more flexible, structured, and sustainable (Huda et al., 2026; Shafa, 2024). LMS allows teachers to manage learning materials, activities, and evaluations in one integrated digital environment, so that the learning process is no longer completely dependent on face-to-face space and time (Retnoningsih, 2017; Risti, 2025). Among the various LMSs available, Moodle is widely used because it is *open-source*, easily adaptable to learning needs, and supports a wide range of pedagogical activities. However, the effectiveness of Moodle is not only determined by the availability of technological features, but also by the ability of teachers to integrate them pedagogically (Gamage et al., 2022; Yüksel, 2022). Mastery of the *Technological Pedagogical Content Knowledge* (TPACK) framework is important so that

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technology is not used separately, but is in line with the learning objectives and characteristics of the teaching material (Mustika & Temarwut, 2022).

In line with the demands of 21st-century learning, *Project-Based Learning* (PjBL) is evolving as an approach that emphasizes active, collaborative, and student-centered learning through authentic project completion (Rafik et al., 2022; Taufiqurrahman & Junaidi, 2021). The integration of PjBL with Moodle provides an opportunity for teachers to design systematic learning, from project planning to reporting results, while facilitating interaction and collaboration between students in a digital environment (Kisworo et al., 2021; Sidiq & Wantoro, 2024). In the context of project-based learning, students are required to have *self-regulated learning* (SRL) skills in order to be able to manage the learning process independently. The Moodle environment supports the development of self-regulation through task management features, learning progress monitoring, and continuous feedback, so that students are encouraged to plan, monitor, and evaluate their learning process more reflexively (Kusuma et al., 2021; Pohan & Maulina, 2022).

A number of studies show that Moodle is effectively used as a digital learning medium that supports the delivery of materials, learning interactions, and evaluation in an integrated manner. The use of Moodle allows learning to take place more flexibly and encourages students to engage in independent and collaborative learning activities (Inggriyani et al., 2019). Furthermore, the implementation of *Moodle-assisted Project-Based Learning* is reported to be able to improve the quality of learning, critical thinking skills, and active student involvement. The Moodle environment supports systematic project management, so that PjBL can be effectively applied in both online and *blended learning* (Maulina et al., 2022; Ruslan et al., 2024). In addition to having an impact on learning outcomes, the integration of PjBL and Moodle also contributes to the development of *self-regulated learning*. Project-based learning in a digital environment encourages students to take an active role in planning, monitoring, and reflecting on their learning process, which is at the core of self-regulation in learning (Marnola et al., 2024; Zarouk, 2020).

Although many studies on Moodle and PjBL have been conducted, most of the research still focuses on learning effectiveness or improving student learning outcomes. Studies that specifically review how the integration of Moodle by teachers contribute to the development of *self-regulated learning* in the context of *Project-Based Learning* are still relatively limited and scattered in various studies with diverse focuses. In addition, Moodle in many studies is still positioned as a technical support media, not fully studied as a learning environment that actively facilitates students' self-regulation. This condition shows the need for a study that synthesizes research findings to gain a more complete understanding of the role of Moodle in supporting PjBL and *self-regulated learning* simultaneously.

Based on these gaps, this study is considered important to comprehensively examine how Moodle is integrated by teachers in the implementation of *Project-Based Learning* and its contribution in supporting students' *self-regulated learning*. The *Systematic Literature Review* approach is used to collect, analyze, and synthesize relevant research results in a systematic and structured manner.

This study aims to analyze the integration of Moodle in the implementation of *Project-Based Learning* and its role in supporting *students' self-regulated learning*. In particular, this study aims to identify the form of Moodle integration by teachers, the use of Moodle features in PjBL, and its impact on self-regulation, learning engagement, and student learning outcomes.

METHOD

This study uses the *Systematic Literature Review* (SLR) approach which aims to identify, evaluate, and systematically synthesize the results of previous research relevant to the topic of technology integration by teachers through Moodle to support self-regulated learning in project-based learning. The SLR implementation process is prepared based on the guidelines of PRISMA (*Preferred Reporting Items for Systematic Reviews and Meta-Analyses*) to ensure transparency, consistency, and accuracy of search procedures and literature selection.

The source of research data was obtained from the Google Scholar database accessed through the Publish or Perish (PoP) application. The article search was conducted by considering the broad coverage of Google Scholar to national and international publications in the field of education and learning technology. Literature search using a combination of *Moodle*, *Self-Regulated Learning*, *Project-Based Learning*, *Technology Integration*, and *Learning Management System* keywords combined with Boolean operators (*AND*, *OR*). Articles searched are limited to publications in the period 2017 to the present to ensure relevance to the latest developments in learning technology.

In the context of this study, *participants* do not refer to individuals directly, but to research articles that are the unit of analysis. These articles are empirical studies that discuss the use of Moodle, self-regulated learning, and/or project-based learning in the context of formal education. The research population includes all scientific articles identified through Google Scholar in the 2017–present time frame and related to the study topic. The sampling technique used is *purposive sampling*, which is the deliberate selection of articles based on inclusion and exclusion criteria. Inclusion criteria include scientific journal articles that have gone through *a peer-review* process, are available in full text, are written in Indonesian or English, and are relevant to Moodle integration, self-regulated learning, and project-based learning. Articles that were irrelevant, inaccessible, or did not meet the focus of the study were excluded from the study sample.

The main instrument in this study is in the form of data extraction sheets, which are used to collect and organize important information from each article reviewed. The data extracted included the author and year of publication, the research objectives, the research method, the context and subject of the research, the form of Moodle integration, as well as key findings related to self-regulated learning and project-based learning. Because this study is a literature review, no instruments in the form of tests or questionnaires are used, so the validity and reliability aspects of statistical instruments are not applied directly. However, the quality of the data is maintained through a strict and systematic article selection process. Research support instruments include the Publish or Perish application as a tool for searching and managing bibliographic data, a PRISMA checklist to ensure the completeness and clarity of the SLR stages, and an article synthesis table used to compare and analyze research findings thematically.

The article selection procedure is carried out manually by following four main stages according to the PRISMA guidelines. At the identification stage, the initial search yielded 163 articles from Google Scholar using Publish or Perish. At the screening stage, 67 articles were deleted due to duplication, leaving 96 articles. Furthermore, screening by title and abstract was conducted, and 50 articles were eliminated as irrelevant to the focus of the research, resulting in 46 articles. The eligibility stage was carried out through a complete text review of the 46 articles. At this stage, 8 articles were removed for not being accessible or paid, and 12 articles were eliminated for not meeting the relevance of the content. Thus, at the inclusion stage, 26 articles were obtained that met all inclusion criteria and were used in the thematic analysis and synthesis of this research. The entire research process is carried out in one research period that is adjusted to the needs of scientific article preparation.

Data analysis was carried out using descriptive and thematic analysis. The selected articles were analyzed by grouping findings based on the form of Moodle integration in project-based learning, the role of Moodle in supporting self-regulated learning, and the impact of Moodle integration on student learning processes and outcomes. The analysis was conducted narratively without an inferential statistical test because this study did not involve primary quantitative data. The scope of this study is limited to articles obtained from the Google Scholar database in the 2017–present time frame. The limitations of the study lie in the use of one main database and the possibility of variations in methodological quality in the studies reviewed. In addition, some relevant articles could not be analyzed due to limited access to the full text.

The writing and reporting of the results of this study refers to the PRISMA guidelines, which are recommended for research with a systematic literature review design to ensure transparency, traceability of the selection process, and quality of research methodology.

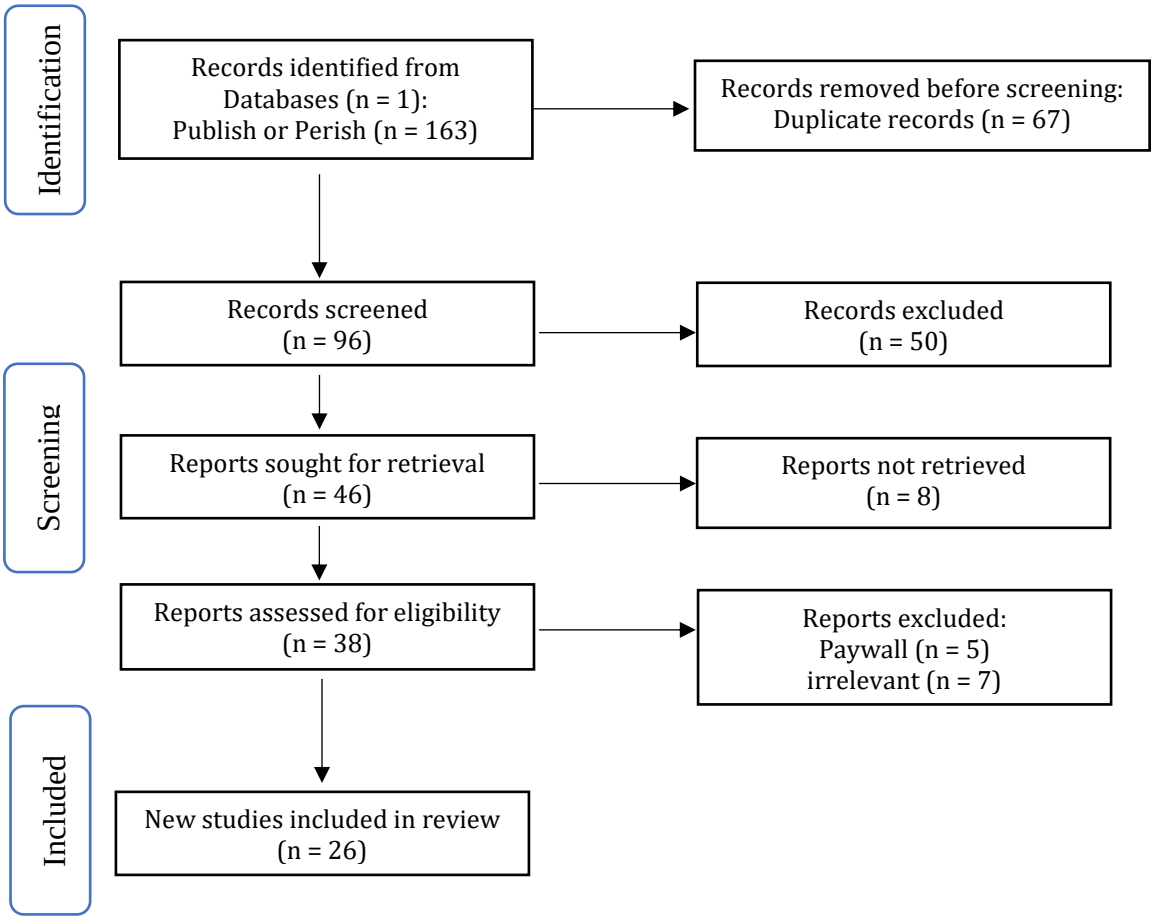

Figure 1. Literature Selection Flow Diagram Based on PRISMA Guidelines

RESULTS AND DISCUSSION

Results

1. Overview of Reviewed Articles

The results of the study of 26 articles show that research on the integration of Moodle in learning, especially those associated with *Project-Based Learning* (PjBL) and *Self-Regulated Learning* (SRL), has increased significantly in recent years. The distribution of publications by year shows that in the initial period (2017–2019) the number of studies was still limited, with 1 article in 2017 (3.8%), 1 article in 2018 (3.8%), and 1 article in 2019 (3.8%) respectively. In the 2020–2021 period, there was a moderate increase, namely 2 articles in 2020 (7.7%) and 3 articles in 2021 (11.5%). A sharper increase was seen in the 2022–2025 period, with 5 articles in 2022 (19.2%), 5 articles in 2023 (19.2%), 4 articles in 2024 (15.4%), and 4 articles in 2025 (15.4%). This pattern shows the increasing attention of researchers to the use of Moodle as a *Learning Management System* that not only supports online learning, but also active and independent learning after the pandemic.

Judging from the type of research, out of a total of 26 articles reviewed, there were 9 quantitative research articles, which generally used experimental or *quasi-experiment* designs to test the effectiveness of PjBL-based Moodle on students' learning outcomes and *self-regulated learning* abilities. A total of 6 articles usea qualitative approach, which focuses on exploring the experiences of teachers and students in implementing Moodle and PjBL. In addition, 7 articles are research and development (*R*&D) aimed at developing Moodle LMS, modules, or project-based learning features. Meanwhile, the other 4 articles use a *mixed methods* approach, which combines quantitative and qualitative data to obtain a more comprehensive picture.

Based on the research method, the most dominant method is experimental and development research, which shows that most studies are not only descriptive, but also oriented towards the implementation and direct testing of Moodle in the context of project-based learning. Survey and *case study* methods are also used, especially to examine user perceptions, teacher readiness, and the process of student self-regulation during learning. Reviewed from the context and level of education, the articles reviewed cover various levels, ranging from primary education, secondary education, to higher education. However, the majority of research was conducted at the secondary and university education levels, especially in subjects or courses that require high-level thinking skills, collaboration, and learning independence. This is in line with the characteristics of *Project-Based Learning* which emphasizes active and *student-centered learning* (Selasmawati & Lidyasari, 2023).

Overall, the overview of the reviewed article shows that research on Moodle integration is increasingly evolving towards a more meaningful pedagogical approach, particularly in supporting *Project-Based Learning* and the development of *students' self-regulated learning*, rather than simply using technology as a medium for delivering materials.

2. Forms of Moodle Integration by Teachers in Project-Based Learning

The results of the cross-article synthesis show that teachers integrate Moodle in the implementation *of Project-Based Learning* (PjBL) through a series of planned and process-oriented pedagogical practices. Moodle is not only used as a *Learning Management System* for material distribution, but is also used as the main platform in designing project assignments, managing project stages, facilitating group collaboration, and monitoring student learning progress (Pratama, 2025). This integration pattern affirms Moodle's role as a digital learning environment that supports active, collaborative, and student-centered learning.

In the design aspect of project assignments, teachers use Moodle to structure and distribute projects that are authentic and contextual. Project assignments are designed in the form of *a project brief* that contains learning objectives, project descriptions, success criteria, and expected final products. Supporting documents such as assessment rubrics, work guides, and digital learning resources are uploaded through *the resources* and *assignment* features. Cross-study synthesis shows that structured project assignment design in Moodle helps students understand learning expectations early on and encourages their readiness to manage project activities independently.

Furthermore, Moodle is used by teachers in managing project stages. The stages of PjBL, such as problem formulation, project planning, implementation, and presentation of results, are systematically organized in *a course section* or *weekly/topic-based format*. Teachers set timelines, deadlines, and achievement indicators at each stage of the project so that students can follow the workflow gradually. The results of the synthesis show that managing project stages through Moodle helps students in developing planning and timing skills, which are important components of *self-regulated learning*.

In the aspect of group collaboration, Moodle provides an interaction space that allows students to work together online. Teachers form working groups through *the group* feature and facilitate project discussions using *forum discussions*, *chats*, or *collaborative assignments*. This collaboration focuses not only on task sharing, but also on the exchange of ideas, problem-solving, and joint decision-making. Cross-article synthesis shows that Moodle-based collaboration in PjBL contributes to increased student engagement, communication skills, and collective responsibility in completing projects.

Another aspect that stands out is the monitoring of the progress of student projects. Teachers use *the activity completion*, *assignment tracking*, and *grading* features to monitor the progress of each group and individual. Through activity track records in Moodle, teachers can identify delays, learning difficulties, or contribution imbalances in the group. Feedback is given periodically through written comments or *online feedback*, so that students can make improvements and reflections on their learning process. The results of the synthesis show that this continuous

monitoring plays an important role in supporting students' independence and learning responsibility.

Overall, Moodle's integration by teachers in *Project-Based Learning* forms a digital learning ecosystem that supports clear project design, systematic stage management, active group collaboration, and continuous monitoring of learning progress. This pattern shows that Moodle functions as a strategic means in implementing PjBL which is not only oriented to the final product, but also to the learning process and strengthening *students'* self-regulated learning.

3. Moodle Features Used to Support Project-Based Learning

The results of the cross-article synthesis show that the successful implementation of *Moodle-assisted Project-Based Learning* (PjBL) is greatly influenced by the use of key features that support project management, collaboration, and student learning process management. Moodle provides a set of features that allow teachers to integrate all stages of PjBL into one structured and accessible digital learning ecosystem.

The *assignment* feature is one of the most dominant components used in supporting PjBL. Teachers use *assignments* as a means of collecting project products, both individually and in groups. Through this feature, teachers can set deadlines, collection formats, and clear assessment criteria. Cross-study synthesis shows that the use of *assignments* serves not only as a medium for collecting final results, but also as a process control tool, as students are encouraged to manage time, complete tasks gradually, and be responsible for the achievement of their projects.

In supporting project collaboration and discussion, *the forum discussion* feature is widely used. Teachers use the forum as a communication space between group members to discuss project ideas, divide roles, and solve problems that arise during the work process. The forum also serves as a medium of interaction between teachers and students in providing direction, clarification, and feedback. The results of the synthesis show that *forum discussions* encourage active participation, argumentation skills, and student cooperation, which are key characteristics of project-based learning.

The *resource feature* is used by teachers to provide a variety of project support materials, such as learning modules, articles, videos, project templates, and product examples. Through *resources*, students have flexible access to learning resources that are relevant to the project being worked on. Cross-article synthesis shows that the availability of organized learning resources in Moodle helps students understand the context of the project, deepen concepts, and develop learning independence, because students can manage their own time and learning strategies as needed.

In addition, the *calendar feature* plays an important role in project time management. Teachers use *the calendar* to display the schedule of project stages, assignment collection deadlines, and project results presentation agenda. The existence of a project calendar helps students monitor the progress of work and set task priorities. The results of the synthesis show that the use of *calendars* contributes to the improvement of learning discipline and students' awareness of time planning, which is an essential part of *self-regulated learning*.

Overall, the use of *assignment features*, *forum discussions*, *resources*, and *calendars* shows that Moodle is able to accommodate the pedagogical needs of *Project-Based Learning* comprehensively. These features complement each other in supporting project design, group collaboration, provision of learning resources, and time management and student project progress. Thus, Moodle not only serves as a learning administration platform, but as a digital learning environment that supports the effective and sustainable implementation of PjBL.

4. The Role of Moodle Features in Supporting Self-Regulated Learning in Project-Based Learning

The results of the cross-article synthesis show that the integration of Moodle in *Project-Based Learning* (PjBL) plays a significant role in developing students' *self-regulated learning* (SRL). The use of the Moodle feature allows students to manage their learning process independently through the stages of planning (*forethought*), monitoring (*performance control*), and evaluation and *self-reflection (self-reflection*), as stated in the SRL Zimmerman theory.

In the aspect of learning planning (*forethought phase*), *the calendar*, *assignment*, and *resource features* play a role in helping students set goals, manage time, and understand the demands of the project. The project calendar prepared by the teacher allows students to clearly see the stages of work, deadlines, and project achievement targets. Meanwhile, *assignments* that come with assignment descriptions and assessment criteria help students plan project completion strategies. Access to *resources* gives students the opportunity to select learning resources that are relevant to the needs of the project, so that the planning process is not only administrative, but also cognitive and strategic.

In the performance *phase*, *the forum discussion* and *assignment* features are used to monitor student learning progress. The discussion forum serves as a process reflection space, where students report on project progress, discuss obstacles, and receive feedback from teachers and peers. Cross-article synthesis shows that this activity encourages students to monitor the understanding, effort, and learning strategies used during project work. In addition, *assignments* with gradual collection allow students to assess the extent of progress that has been achieved compared to the initial plan, so that students are more aware of their own learning process.

In the aspect of self-evaluation and reflection *(self-reflection phase*), Moodle provides opportunities for students to assess learning outcomes and processes. Through the feedback provided by the teacher in the *assignment*, students can evaluate the quality of the project product as well as the effectiveness of the learning strategies used. Some studies also show the use of *discussion forums* as a final reflection space, where students are asked to express their learning experiences, challenges faced, and solutions found during the project. This process strengthens students' metacognitive awareness and encourages improvement of learning strategies on subsequent projects.

Overall, the cross-article synthesis confirms that Moodle's features support *self-regulated learning* not separately, but integrated within the *Project-Based Learning* flow. Moodle serves as a digital learning environment that facilitates students to plan, monitor, and reflect on learning independently.

5. The Impact of Moodle Integration on Students' Self-Regulated Learning in Project-Based Learning

The results of the cross-article synthesis show that the integration of Moodle in the implementation *of Project-Based Learning* (PjBL) has a positive impact on the development of students' *self-regulated learning*. Moodle not only acts as an online learning medium, but also as a learning environment that encourages students to manage the learning process independently, responsibly, and in a directed manner during the implementation of projects.

From the aspect of learning independence, most of the article report that students become more active in accessing materials, determining learning resources, and managing project completion strategies. The availability of *resource* and *assignment features* allows students to learn without being fully dependent on the teacher's explanations. In the context of PjBL, this independence is reflected in the ability of students to take initiative in project planning, seek additional information, and complete tasks according to the goals that have been set. These findings are in line with the characteristics of *self-regulated learning* that emphasize the active role of students in controlling their learning process.

On the aspect of learning responsibility, Moodle integration encourages students to be more consistent in completing project assignments. Setting deadlines through *assignments* and *calendars* makes students aware of the consequences of delays and the quality of their work. Cross-study synthesis shows that students show increased commitment to their role in the group, completion of the part of the project for which they are responsible, and adherence to mutually agreed learning rules. This shows that Moodle helps instill a sense of *ownership* in the learning process and outcomes.

In terms of time management, the majority of articles emphasize that the use *of calendars* and deadline settings on *assignments* helps students plan and monitor project work schedules. In PJBL which is complex and lasts for a certain period of time, the ability to manage time is a crucial factor.

Moodle provides a clear visualization of the schedule so that students can divide their time between discussions, project work, and revisions. These findings suggest that Moodle integration contributes to improving students' ability to manage time effectively, which is an important component of *self-regulated learning*.

Aspects of self-control and reflection have also improved through Moodle integration. The feedback provided by the teacher through *assignments* and reflective discussions in *the discussion forum* helps students evaluate the process and the results of the project. Some studies report that students become better able to identify their own strengths and weaknesses, control their emotions when facing project difficulties, and adjust the learning strategies used. This process strengthens students' metacognitive awareness and self-regulation ability in the face of project-based learning challenges.

Overall, the impact of Moodle's integration in *Project-Based Learning* is not only seen in improving learning outcomes, but also in strengthening the *self-regulated learning* dimension of students. Independence, responsibility, time management, and self-control develop simultaneously as a result of structured, transparent, and student-centered learning. These findings confirm that Moodle serves as an important facilitator in building students' self-regulation skills through meaningful and sustainable project-based learning.

6. The Impact of Moodle Integration on Student Learning Outcomes and Engagement on Project-Based Learning

The results of the cross-article synthesis show that the integration of Moodle in the implementation *of Project-Based Learning* (PjBL) has a positive impact on student learning engagement and learning outcomes. Moodle functions as a digital learning environment that supports active, collaborative, and student-centered learning activities, thereby strengthening the overall quality of PjBL implementation (Abdelghani, 2021).

From the aspect of active engagement (*student engagement*), most articles report an increase in student participation during the project-based learning process. The use of *forum discussion*, *assignment*, and *resource* features encourages students to engage cognitively, socially, and behaviorally in each stage of the project. Students not only act as recipients of information, but actively discuss, share ideas, and contribute to the completion of group assignments. Cross-study synthesis shows that this engagement increases when teachers provide structured yet flexible interaction spaces through Moodle.

In terms of learning motivation, the integration of Moodle in PjBL has been proven to be able to increase students' interest and intrinsic motivation. An interactive, transparent, and well-documented learning environment makes students more motivated to complete projects optimally (Rizki & Sujatmiko, 2025). Several articles show that clarity of project objectives, ongoing feedback, and ease of access to learning materials through Moodle reinforce students' perceptions of the relevance and meaning of learning. This condition is in line with the PjBL principle which emphasizes contextual and meaningful learning.

Judging from the quality of the project results, the synthesis results show that the products produced by students tend to be more systematic, creative, and in accordance with the assessment criteria. The use *of assignments* allows teachers to set clear assessment rubrics, while discussion and feedback forums help students revise and refine projects. Some studies also report that Moodle supports ongoing project process documentation, so that the quality of the final result reflects a targeted and reflective learning process.

In terms of *learning outcomes*, most quantitative studies report an increase in student learning outcomes after the implementation of Moodle-assisted PjBL. This improvement is not only seen in the cognitive aspect, but also in high-level thinking skills, problem-solving, and cooperation. Cross-article synthesis shows that the combination of the PjBL approach and the use of Moodle creates a learning environment conducive to the development of academic competencies and 21st century skills.

Discussion

1. Teacher's Integration of Moodle as a Project-Based Learning Support Strategy

The integration of Moodle by teachers in the implementation *of Project-Based Learning* (PjBL) can be analyzed through the *framework of Technological Pedagogical Content Knowledge* (TPACK). In this context, teachers are not only required to master Moodle technology technically, but also be able to integrate it with pedagogical knowledge and learning content in a meaningful way. The results of the synthesis show that teachers are effective in integrating Moodle to design project assignments, manage learning stages, and facilitate student collaboration through Moodle features that are relevant to learning objectives. This confirms that technology plays a role as a support for pedagogical strategies, not just a tool for learning administration.

In addition, the application of Moodle-based PjBL is in line with the theory of constructivism which emphasizes learning as an active process in building knowledge through real experience (Prasetya, 2023). Moodle provides a learning environment that allows students to engage directly in the process of exploration, discussion, and reflection during the work on a project (Wambua et al., 2025). Through project-based activities facilitated by *discussion forums*, *assignments*, and *resources*, students construct understanding independently and collaboratively. Thus, learning is no longer centered on the teacher, but on contextual and meaningful student learning activities.

Furthermore, the integration of Moodle in PjBL also strengthens the role of teachers as facilitators and *learning designers*. Teachers play a role in designing learning experiences, managing project flows, and providing continuous feedback through the Moodle platform. This role is in line with a constructivist view that places teachers as supporters of the learning process, not as the only source of knowledge. Therefore, the integration of Moodle by teachers can be seen as an effective pedagogical strategy to implement PjBL systematically and sustainably in 21st century learning.

2. Moodle's Contribution to Developing Self-Regulated Learning in Project-Based Learning

Moodle's contribution in developing *self-regulated learning* (SRL) in project-based learning can be explained through Zimmerman's SRL theoretical framework which includes the planning phases (*forethought*), implementation and monitoring (*performance control*), and self-reflection (*self-reflection*). The synthesis results show that Moodle features such as *assignments*, *progress tracking*, and *feedback* systematically support all three phases. Project assignments with descriptions and assessment criteria help students set goals and plan learning strategies, while progress monitoring and deadlines encourage students to manage effort and time during project work.

In the monitoring and self-control phase, Moodle provides a space for students to evaluate the learning process on an ongoing basis. The *progress tracking* and interaction feature through *forum discussions* allows students to monitor project achievements, compare them with set targets, and adjust learning strategies when facing difficulties. This condition strengthens students' metacognitive awareness and self-control, which is at the core of *self-regulated learning*. Thus, Moodle serves as an external regulation tool that helps students develop internal self-regulation gradually.

In the perspective of Bandura's social cognitive theory, the integration of Moodle in *Project-Based Learning* (PjBL) also contributes to the increase of students' intrinsic motivation and self-efficacy (Beketov et al., 2024). Successful completion of project assignments, positive feedback from teachers, and social interaction with peers through Moodle strengthen students' confidence in their own abilities (*self-efficacy*). This encourages students to be more confident, persistent, and responsible in managing project-based learning. Thus, Moodle not only supports the technical aspects of learning, but also plays an important role in building students' motivation and self-regulation in a sustainable manner.

3. Moodle Integration Compatibility with *Project-Based Learning Characteristics*

Moodle's integration in *Project-Based Learning* (PjBL) demonstrates a strong fit with the learning experience cycle in Kolb's *experiential learning* theory, which includes *concrete experience*, *reflective observation*, *abstract conceptualization*, and *active experimentation*). Moodle facilitates

the project planning stage through the provision of *resources* and task descriptions on *assignments*, allowing students to understand the context and objectives of the project before starting the activity. During the implementation phase, students engage in real learning experiences through project work, discussion, and collaboration facilitated by *the forum discussion* feature.

The reflection and evaluation stages in the Kolb cycle are also optimally supported through Moodle. The feedback given by the teacher on *the assignment* as well as the reflective discussion in the forum helped students evaluate the process and the results of the project that had been worked on. Through this reflection, students develop a deeper conceptual understanding and are able to relate project experiences to the theoretical concepts learned. Furthermore, the results of the reflection are used by students to make improvements and develop strategies for the next project, so that the learning cycle takes place continuously.

In addition to being in line with *experiential learning*, the Moodle environment also strengthens the *student-centered learning* approach that is the main characteristic of PjBL. Moodle gives students greater control over the learning process and tempo, from time management, selection of learning resources, to project completion strategies. The role of teachers shifts to become facilitators who direct and accompany the learning process. Thus, Moodle integration is not only compatible with the characteristics of PjBL, but also strengthens student-centered learning and encourages active engagement and learning responsibility.

4. Pedagogical Implications for Teachers in Implementing *Moodle-Assisted* Project-Based Learning

The pedagogical implications of the implementation of *Moodle-assisted Project-Based Learning* (PjBL) affirm the shift in the role of teachers from material presenters to learning facilitators. In this context, teachers play a role in guiding students in developing *self-regulated learning*, starting from planning, monitoring, to learning reflection. Through the use of the Moodle feature, teachers can design a structured learning experience while providing space for students to manage their learning process independently. The role of this facilitator is in line with the modern learning paradigm that emphasizes active involvement and student learning responsibility.

In addition to guiding self-regulation, teachers also play a role in creating a collaborative learning environment that supports the development of 21st century skills. The *forum discussion* and group-based assignment features in Moodle allow students to develop collaboration, communication, and problem-solving skills during project work. Teachers need to direct these interactions to stay focused on learning objectives, while encouraging balanced participation among group members. Thus, project-based learning not only produces academic products, but also develops students' social and cognitive competencies.

Furthermore, the implementation of PjBL assisted by Moodle requires teachers to have integrated pedagogical and technological competencies. Teachers need to design authentic projects, set transparent assessment criteria, and provide constructive and ongoing feedback through the Moodle platform. This practice supports strengthening students' learning independence, collaboration, and problem-solving abilities as part of 21st century skills. Therefore, the integration of Moodle in PjBL not only has an impact on the learning process, but also becomes a relevant pedagogical strategy to prepare students to face the challenges of learning and life in the future.

Implications

The use of Moodle-assisted project-based learning has important pedagogical ramifications for instructors' transition from content providers to facilitators and learning experience designers. Teachers may help students build self-regulated learning skills with this platform, from planning to learning reflection. Strong Technological Pedagogical Content Knowledge (TPACK) competences are also necessary for this integration in order for teachers to create real projects, set clear evaluation standards, and give ongoing feedback to help students get ready for new challenges.

Research contribution

This study provides a theoretical contribution by synthesizing how Moodle features such as assignments, forum discussions, resources, and calendars systematically support the phases of planning (forethought), implementation (performance control), and self-reflection within the framework of student self-regulation. Practically, this research shows that adding Moodle to PjBL not only provides technical assistance but also creates a digital ecosystem that encourages active student participation, responsibility, and the quality of their project outcomes. These results provide education practitioners with a scientific basis for optimizing LMS to build 21st-century skills.

Limitations

The limitations of this study lie in the scope of the literature search, which was sourced from only one main database, namely Google Scholar, covering the period from 2017 to the present. There is also the possibility of variations in the methodological quality of the studies reviewed, which may affect the generalizability of the synthesis results. In addition, a comprehensive analysis could not be performed on several articles considered relevant due to access constraints to the full text or documents behind paywalls.

Suggestions

Based on the existing results, researchers should conduct further in-depth research to determine whether Moodle, PjBL, and self-regulation correlate with each other at various levels of education. Education practitioners should not only use Moodle as an administrative tool; instead, they should utilize its interactive features to help students collaborate and work independently. Finally, teachers need to receive better professional development so that they can create effective and sustainable project-based learning designs in a digital environment.

CONCLUSION

This study concludes that the integration of Moodle by teachers in the implementation *of Project-Based Learning* (PjBL) consistently supports the development of students' *self-regulated learning*, as the objectives formulated in the introduction. The results of *the Systematic Literature Review* show that the use of Moodle features such as *assignments*, *forum discussions*, *resources*, and *calendars* allow teachers to design project-based learning that is structured, collaborative, and student-centered. This integration not only supports the PjBL stage, but also strengthens learning independence, responsibility, time management, self-control, and student learning engagement and motivation, in line with the framework of *Zimmerman's* self-regulated learning *theory, Bandura' s* social cognitive theory*, and Kolb's* experiential learning.

Furthermore, the findings of this study show that Moodle has the potential to be a strategic platform in optimizing the implementation of PjBL and 21st century skill development. As a future prospect, the results of this study can be the basis for further empirical research that in-depth examines the causal relationship between the integration of Moodle, PjBL, and *self-regulated learning* at various levels of education. In addition, these findings are expected to be used by education practitioners in designing more effective, meaningful, and sustainable Moodle-assisted project-based learning.

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AUTHOR CONTRIBUTION STATEMENT

The lead author and researcher of this article, SY; is responsible for the formulation of research concepts and designs, the collection and selection of articles, data analysis, and the writing and preparation of article manuscripts. SY; also synthesize findings, discuss research results, and finalize manuscripts before publication.

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