



DESIGNING AND VALIDATING A PROBLEM-BASED LEARNING GAMIFICATION MODEL TO ENHANCE TEACHING COMPETENCIES AMONG PROSPECTIVE ELEMENTARY ISLAMIC SCHOOL TEACHERS

Wiku Aji Sugiri¹⁾, Rizki Amelia²⁾, Sigit Priatmoko³⁾,
Agus Mukti Wibowo⁴⁾, Tsaniyah Nafi'ah⁵⁾

^{1,2,3,4,5}Pendidikan Guru Madrasah Ibtidaiyah, Fakultas Ilmu Tarbiyah dan Keguruan, Universitas
Islam Negeri Maulana Malik Ibrahim Malang, Indonesia
E-mail: rizkiamelia@uin-malang.ac.id

Submit: 13 November 2025, **Revision:** 24 Mei 2026, **Approve:** 25 Mei 2026

Abstract

This study aimed to develop and validate a Problem-Based Learning Gamification (PBLG) model to enhance the teaching competencies and learning engagement of prospective Madrasah Ibtidaiyah (Islamic Elementary School) teachers. Addressing the pedagogical gap in teacher education, this Research and Development (R&D) study utilized the ADDIE framework involving 61 prospective teachers at Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia. Data were comprehensively collected through expert validation, questionnaires, observations, and interviews. Emphasizing the research outcomes, expert validation confirmed the PBLG model's robust theoretical foundation and syntactic clarity with a highly valid score of 98.12%. The implementation phase demonstrated exceptional effectiveness, yielding an overall student response score of 4.46 out of 5 (Very High category). Specifically, the model significantly boosted learning engagement and motivation (4.50), satisfaction (4.55), gamification attractiveness (4.47), team collaboration (4.40), and material understanding (4.36). Furthermore, the preliminary analysis accommodated students' strong preference for blended learning (73.6%) and digital gadget integration. In conclusion, integrating gamification elements into PBL syntax provides a highly valid and engaging instructional framework that effectively improves prospective teachers' pedagogical motivation and problem-solving abilities.

Keywords: Model Development, Problem-Based Learning, Gamification, Prospective Teachers, Academic Validity

Quotation: Sugiri, Wiku Aji, et.al. (2026). Designing and Validating a Problem-Based Learning Gamification Model to Enhance Teaching Competencies Among Prospective Elementary Islamic School Teachers. *JMIE: Journal of Madrasah Ibtidaiyah Education*, 10 (1), 2026, 226-246. [jmie.v10i1.862](https://doi.org/10.32934/jmie.v10i1.862).

Permalink/DOI: <http://dx.doi.org/10.32934/jmie.v10i1.862>

INTRODUCTION

Problem-Based Learning (PBL) has been widely recognized as a pivotal pedagogical approach for fostering critical thinking and problem-solving skills by immersing students in authentic, real-world scenarios (Aini et al., 2021; Guerra et al., 2017; Henriksen, 2015). This model encourages active inquiry, the integration of theory and practice, and the application of knowledge to address complex challenges (Guerra et al., 2017; Kofoed et al., 2018; Smith et al., 2022). In the context of teacher education, PBL serves as a bridge between theoretical constructs and practical classroom applications, which is essential for sharpening the analytical, evaluative, and creative abilities of prospective teachers (Guerra et al., 2017; Jensen et al., 2021; Thomas, 2009; Yanto, 2019).

However, a significant challenge persists in how prospective teachers transition from theoretical understanding to actual pedagogical execution. Mastery of pedagogical skills, specifically in facilitating learning and guiding students through complex classroom activities, remains a documented hurdle in teacher education (Mustakim et al., 2024). Prospective teachers often struggle to maintain student engagement and manage classroom dynamics when faced with the unpredictable nature of real-time learning. This pedagogical gap indicates that understanding the mechanics of a teaching model is insufficient without the ability to proactively manage and motivate a diverse classroom environment (Henriksen, 2015; Mustakim et al., 2024).

To address this limitation, integrating gamification, incorporating elements such as challenges, instant feedback, and clear rules, offers a strategic pedagogical solution. Gamification has been proven to significantly boost academic achievement, cognitive engagement, and intrinsic motivation, particularly when integrated into learning management systems (Chan & Lo, 2024; Dichev & Dicheva, 2017; García-López et al., 2023; Mitchell & Co, 2024; Pařová & Vejačka, 2022). Consequently, combining PBL with gamification creates a synergistic environment that not only promotes deeper learning but also proactively engages students through interactive challenges, overcoming the enthusiasm deficits found in traditional settings (Jaramillo-Mediavilla et al., 2024; Klock et al., 2015; Mao & Lucas, 2024).

Despite the extensive literature acknowledging the individual benefits of PBL and gamification, their integration remains fragmented, particularly within the context of Islamic elementary teacher education (PGMI). Existing studies predominantly focus on gamification as a general student engagement tool or isolate cognitive outcomes, neglecting the broader pedagogical implications (Khaldi et al., 2023; Kim & Sakir, 2020). There is a conspicuous scarcity of research critically analyzing how an integrated Problem-Based Learning Gamification (PBLG) model can be scaffolded to improve prospective teachers' professional fluency in designing strategies and guiding investigations (Jumadi et al., 2021; Wijnia, 2024). Most current models fail to explicitly map gamified elements to the development of specific teacher

facilitation skills. To address this gap, this study introduces and validates a PBLG model that distinctly prioritizes the acquisition of pedagogical skills alongside student engagement (Isnayah & Iswatiningsih, 2025; Kaur et al., 2025)(Isnayah & Iswatiningsih, 2025; Kaur et al., 2025), providing a practical and innovative instructional framework for teacher education (Poluru, 2024).

The aim of this study is to develop a Problem-Based Learning model integrated with gamification, specifically designed for prospective elementary school teachers, and to evaluate its effectiveness in enhancing their motivation and engagement. This model will explore how the application of gamification elements, such as points, badges, and leaderboards, can be effectively integrated into the PBL stages to foster active participation and critical reflection among prospective teachers (Gutiérrez & López, 2016; Isnayah & Iswatiningsih, 2025; Kaur et al., 2025; Poluru, 2024). This approach is expected to provide a solid framework for curriculum developers and educators to design more dynamic and relevant learning experiences (Ishaq et al., 2025; Panis et al., 2020), consistent with contemporary educational needs that emphasize active engagement and continuous learning (Gutiérrez & López, 2016; Isnayah & Iswatiningsih, 2025). This research will systematically outline the design, implementation, and evaluation of this model, based on established pedagogical principles (Panis et al., 2020) and the latest gamification theories, such as the strategic use of points, badges, levels, and leaderboards to reinforce positive learning behaviors (Al-Hafdi & Alhalafawy, 2024; Kaur et al., 2025; Papp, 2017). To ensure methodological rigor and alignment between the research problem and the findings, this study is guided by the following explicit research questions:

1. What are the fundamental characteristics and theoretical validity of the PBLG model designed to enhance the teaching competencies of prospective teachers?
2. How does the implementation of the PBLG model impact the engagement, motivation, and practical understanding of prospective teachers regarding classroom facilitation?

METHODS

The development of the Problem-Based Learning Gamification (PBLG) model in this study employed the ADDIE model, which consists of five stages: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. The detailed procedures and the specific supporting products generated for these stages are presented in Table 1 below.

Table 1. PBLG Model Development Procedure

Phases	Activity	Output
Analysis	<ul style="list-style-type: none"> Administering questionnaires regarding learning understanding and experiences, needs and expectations for the PBLG model, technical and infrastructure readiness, and gamification design preferences. Curriculum analysis 	List of PBLG development requirements
Design	<ul style="list-style-type: none"> Designing the model structure, learning content, and necessary gamification elements. Determining the platform to be used as the Learning Management System (LMS). 	PBLG model structure blueprint
Development	<ul style="list-style-type: none"> Developing relevant digital content and case studies. Integrating gamification elements such as points, levels, badges, leaderboards, and challenges. Developing the Semester Learning Plan (RPS—Rencana Pembelajaran Semester). Model validation testing. Model revision. 	<ul style="list-style-type: none"> PBLG model syntax Model validity score
Implementation	<ul style="list-style-type: none"> Determining the trial sample. Implementing the PBLG model in class. Distributing student response questionnaires. 	<ul style="list-style-type: none"> Trial sample PBLG implementation report
Evaluation	<ul style="list-style-type: none"> Analyzing student response data. Analyzing data from observation of PBLG implementation. 	Final PBLG model syntax

This research and development was conducted at the Islamic Elementary School Teacher Education Program (PGMI) of Maulana Malik Ibrahim State Islamic University, Malang. It involved 31 students who served as the trial subjects and 30 students served as the control group. To validate the model's syntax, four experts in instructional technology and material content were engaged as validators.

Data were collected through various methods. Questionnaires were used to gather data on student learning preferences, model validation, and student responses to the model. Observation was utilized to collect data on the model's implementation. Interviews were

conducted to collect data on suggestions for model design improvements. Documentation was employed to ascertain the model's relevance to the PGMI Study Program curriculum.

Data analysis was performed in two forms: qualitative and quantitative. Qualitative data analysis used thematic analysis techniques following the interactive model developed by Miles et al., (2014), which includes data collection, data condensation, data display, and conclusion drawing. Quantitative analysis utilized descriptive statistics by calculating percentages to analyze model validation results and student responses. The formula used was as follows:

$$P = \frac{X_a}{X_m} \times 100\%$$

Where:

P = total score of the assessment results by each validator

X_a = the sum of scores from each validation item paramete

X_m = the sum of the maximum possible validation scores

Furthermore, to interpret and determine the predicate for the tested product, the researcher referred to the feasibility criteria table adapted from Sugiri (2023):

Table 2. Product Feasibility Criteria

Category	Percentage Level	Qualification	Equivalent
A	80% - 100%	Valid	Highly Feasible
B	60% - 79%	Sufficient	Feasible
C	50% - 59%	Less	Less Feasible
D	0% - 49%	Not Valid	Not Feasible

RESULTS AND DISCUSSION

Preliminary Study and Need Analysis

According to Branch & Varank, (2009), the purpose of the analysis phase is to identify potential causes of performance gaps. In this stage, the researchers conducted an analysis of the needs for the product to be developed.

a. Learning Style

According to Branch & Varank, (2009), the primary purpose of the analysis phase is to identify the underlying causes of performance gaps and establish an empirical justification for the developed product. To achieve this, a preliminary study was conducted at the Islamic Elementary School Teacher Education Program (PGMI) of Maulana Malik Ibrahim State Islamic University, Malang. This initial study aimed to evaluate prospective teachers'

technological readiness, learning style preferences, and specific pedagogical constraints in developing essential teaching competencies.

The empirical data revealed a high readiness for technology-enhanced learning environments among the participants. In terms of learning styles, the majority of prospective teachers displayed a remarkably positive preference for utilizing digital devices in their learning processes; specifically, 34.7% of students were highly enthusiastic about gadget-based learning, and 59.7% expressed a strong preference for device integration, while a minimal 5.1% showed low enthusiasm. This aligns with contemporary literature indicating that Generation Z learners, who currently dominate higher education demographics, thrive in technology-rich environments and exhibit distinct information-seeking behaviors (Ishak, 2022). This high digital acceptance can be interpreted through the lens of the Technology Acceptance Model, where perceived ease of use (Papatheochari et al., 2024; Torres et al., 2006) and intrinsic user motivation significantly lower the barriers to e-learning adoption (Yuliati et al., 2026; Zhang et al., 2008).

Furthermore, flexibility in learning schedules emerged as a critical requirement, with 43.1% of students indicating a strict need for flexible study time and 56.9% categorizing it as highly important. This demand reflects the broader modern shift in higher education where prospective teachers frequently balance academic coursework with professional training or external commitments (Keane et al., 2022; Ramsaroop et al., 2024; Remojo & Cacho, 2025; Varadharajan et al., 2019). Consequently, 73.6% of the surveyed students favored a blended learning methodology that seamlessly fuses online and offline delivery modes, whereas only 20.4% preferred conventional face-to-face instruction, and a mere 6% opted for entirely online paths.

Crucially, the preliminary study identified severe instructional time constraints for active classroom research, alongside a pronounced gap in students' practical teaching capabilities. Regarding instructional material delivery, 63.9% of students preferred concise, microlearning-style content directly focused on core concepts, and 75.5% required a structured, sequential arrangement from foundational to advanced tasks. To resolve the tension between limited instructional time and the rigorous demand for deep pedagogical mastery, these findings strongly justified the design of a condensed 4-session hyper-flipped classroom model. This optimized framework maximizes limited face-to-face sessions for high-intensity teaching simulations, allowing independent online modules to handle foundational theories. This

strategic structure directly targets the rapid development of prospective teachers' student engagement strategies and advanced procedural skills in classroom facilitation.

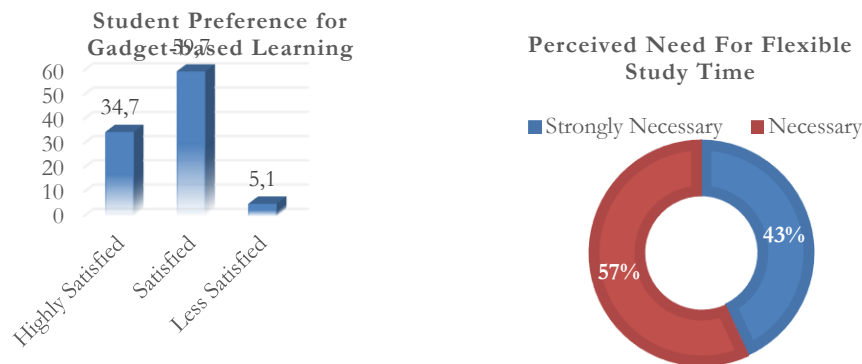


Figure 1. Students' Learning Style Preferences

b. Learning Method

Regarding learning methods, 73.6% of students preferred a blended learning approach that combines online and offline instruction, while 20.4% favored direct face-to-face learning, and only 6% opted for fully online instruction. This strong preference for blended learning is consistent with the global educational paradigm shift that recognizes the importance of flexibility, personalization, and technology integration in the learning experience (Anthony et al., 2020; Dziuban et al., 2018; Ibrahim & Nat, 2019). Blended learning has been widely proven effective in enhancing student engagement and learning outcomes across various disciplines, allowing the combination of the advantages of face-to-face interaction with the accessibility of digital resources and materials (Anthony et al., 2020; Dziuban et al., 2018; Ibrahim & Nat, 2019).

Students also showed a strong inclination towards accessing instructional materials independently, with 21.8% strongly favoring independent access anytime and anywhere, and 62.5% liking this method. Only 15.3% felt less comfortable with this method, indicating that the majority of students require flexible access to learning materials. The need for learning autonomy and independent access to resources is a key characteristic of 21st-century students (Zhu & Jiang, 2025), demanding learning models that can accommodate individual learning styles and diverse schedules (Bates, 2015; Shurygin et al., 2021; Valtonen et al., 2020). Research suggests that learning environments that provide choices aligned with varied learning preferences can foster learner autonomy in higher education (DeMartini & Villemare, 2023; Dolmans, 2019; Fujii, 2024).

c. Instructional Material Characteristics

Regarding the content of instructional materials, 63.9% of students desired content that was brief and directly focused on the core material, while 31% preferred content that covered the entire material comprehensively. Meanwhile, only 5.1% wanted content with very in-depth details. This preference highlights the importance of efficient information delivery and a focus on core learning in microlearning.

In terms of material presentation, the majority of students (75.5%) preferred a systematic learning approach, starting from the easiest material to the more difficult (Figure 4). Conversely, 24.5% of students chose a random learning approach, based on the topics they wished to study at a particular time. This indicates that most students desire a clear and regulated structure in the arrangement of instructional materials.

Design

In this phase, the researchers designed the conceptual framework of the Problem-Based Learning Gamification (PBLG) model by aligning constructivist pedagogical principles with game design elements. The structural syntax of the model was adapted from Arends' Problem-Based Learning framework, which provides a solid foundation for addressing real-world problems through collaborative inquiry (Anazifa & Djukri, 2017; Prahani et al., 2020). To specifically target the development of teaching competencies among prospective elementary school teachers, this standard PBL syntax was systematically integrated with core gamification elements, including points, levels, badges, leaderboards, and rewards.

The primary objective of the PBLG framework is to bridge the gap between theoretical knowledge and practical teaching execution by focusing on essential pedagogical skills. The integration of gamification elements within the PBL steps serves as a motivational mechanism that directly supports teachers' classroom activities, such as facilitating learning and guiding students during investigations. Rather than viewing PBL and gamification as separate entities, the model fuses them: the real-world scenarios of PBL provide the professional substance, while gamification elements (such as leveling up and earning rewards upon completing instructional milestones) stimulate active participation and critical reflection. This combined approach ensures that prospective teachers actively develop their classroom management and facilitation competencies within a structured, engaging, and dynamic instructional environment. Figure 5 presents the framework of the problem-based gamification learning model to be developed.

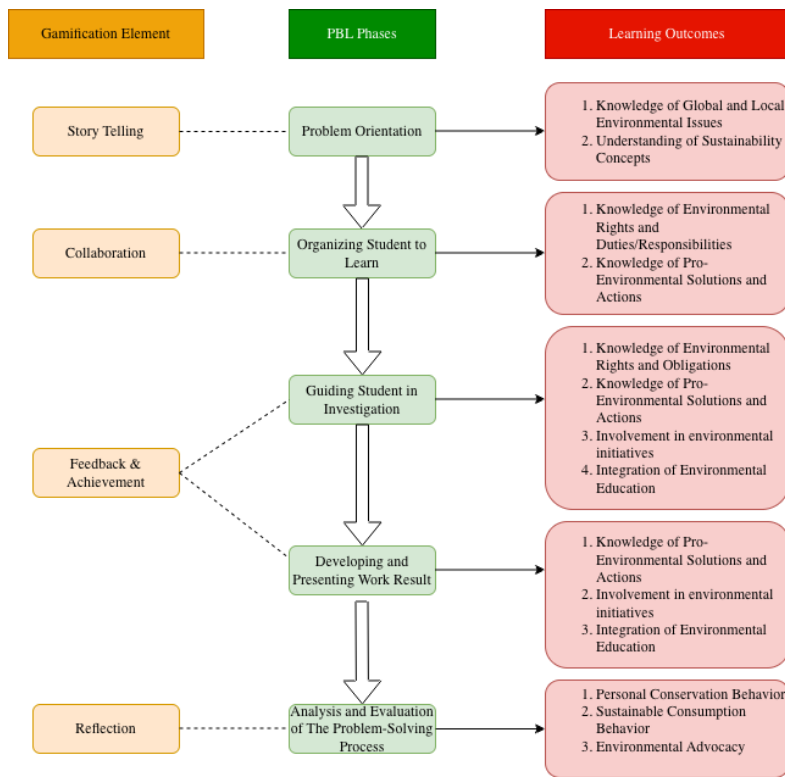


Figure 2. PBLG Learning Model Framework

Development

During the development phase, the conceptual framework was translated into a comprehensive PBLG instructional package. To support the robust implementation of the model and explicitly address the development of teaching competencies, several key supporting products were developed: (1) the PBLG Syntax Guidebook, (2) a Gamified Semester Learning Plan (RPS) tailored for prospective teachers, (3) Pedagogical Competency Assessment Instruments focused on classroom management, and (4) LMS-based Digital Media to host the gamified elements. These products were designed to systematically scaffold prospective teachers' abilities to manage classroom activities and pedagogical interventions.

The developed model and its supporting products subsequently underwent rigorous evaluation by four experts in instructional technology and content design. As presented in Table 3, the validation results yielded an overall average score of 98.12%, categorizing the PBLG syntax as "Highly Valid" and feasible for implementation.

Beyond the quantitative scores, the qualitative feedback from the validators (summarized in Table 4) provided critical insights for refining the model's syntax. Based on these recommendations, the researchers implemented several vital refinements to ensure the model aligned perfectly with the goal of improving teaching competencies.

First, to address concerns regarding syntactic clarity, the integration between PBL and gamification was made explicit: gamification elements (such as points, levels, and rewards) were explicitly highlighted within the syntax to ensure they directly supported the targeted pedagogical skills rather than serving as mere entertainment (Boom-Cárcomo et al., 2024; Čubela et al., 2023). Second, and most importantly, in response to validator feedback regarding the explicit "Lecturer Role," the syntax was heavily revised to emphasize the active role of the educator in facilitating learning and guiding students. In the PBLG context, the lecturer acts not merely as a game moderator, but as a pedagogical model who scaffolds prospective teachers' problem-solving processes and demonstrates effective teachers' classroom activities (Ghani et al., 2022). Third, comprehensive implementation examples were integrated into the guidebook to clarify how prospective teachers should utilize the gamified problem-based scenarios to practice their classroom facilitation skills in real-time. The following are the validation results of the development product:

Table 3. PBLG Syntax Validation Test Results

Validator	Total Score	Average Validator Score	Percentage of Validity
VA	80	4.00	100%
VB	80	4.00	100%
VC	76	3.80	95.0%
VD	78	3.90	97.5%
Total/Overall Average	314	3.925	98.12%

The percentage value obtained from the validation results in Table 3 is 98.12%. If referencing the feasibility criteria table (Table 3), the developed syntax falls into the "Valid" and "Highly Feasible" categories for student trial. Meanwhile, qualitative suggestions are presented in the following table:

Table 4. Suggestions for Problem-based Gamification Syntax Development

Validator	Suggestion
VA	<ul style="list-style-type: none"> • Syntactic Clarity: Clarify the relationship between the models (fusion or integration/collaboration of PBL and gamification) and consider simplifying the syntax. • Gamification Emphasis: Explain or highlight gamification components in the syntax for easy identification (given that PBL is more familiar). • Time Allocation: Specify the duration of implementation (e.g., number of meetings) up to the assessment and evaluation stage. • Content Suitability: Pay attention to the depth of the content/material presented, given the breadth of the pro-environmental behavior concept and the scope of the three taxonomic components. • Lecturer Role: Consider including an explicit component regarding "active and guiding lecturers."

VB	<ul style="list-style-type: none"> • Provision of Real Implementation Examples: Comprehensive guidance needs to be supplemented with real implementation examples in the classroom to facilitate lecturers and students. • Improved Visual Readability: It is recommended to add visual illustrations or a learning flow scheme to enhance the clarity and readability of the guidance.
VC	In the PBL-based Gamification Model syntax, the aspects of level and rewards need to be further clarified, as they are essential elements of gamification.
VD	<ul style="list-style-type: none"> • In the presentation of the syntax, it will be easier for the reader if a summary table is included comparing Arends' and Kapp's theories (e.g., columns for "PBL Step – Game Element – PECB Goal"). • Add a visual model flow (flowchart) to strengthen the structural understanding of the developed model.

Third, the researchers clearly defined the duration of the model's implementation, for example, over several meetings up to the assessment and evaluation stage, to make it more structured. Research suggests that gamification experiences lasting more than one semester have a greater impact on improving learning outcomes, knowledge retention, and deep understanding, emphasizing the importance of long-term intervention (Li et al., 2023). Fourth, attention was paid to the instructional material components that cover the three main taxonomies to ensure the Pro-Environmental Citizenship Behavior concept is conveyed effectively. Gamification in PBL has been applied in environmental education to instill environmental concern and awareness (Nova et al., 2020; Syafi'udin et al., 2020), as well as to enhance environmental literacy, including pro-environmental knowledge, sensitivity, and attitudes (Chuang, 2009). This approach is also effective in developing pro-environmental behavior through increased knowledge of climate change and connection to nature (Runnerstrom et al., 2024). Fifth, the aspect of "active lecturer as guide" was added to reinforce the lecturer's role in the learning process. In PBL, the facilitative role of educators is crucial for providing guidance and supporting student self-directed learning (Čubela et al., 2023; Ghani et al., 2022).

Implementation

Subsequently, the validated model syntax proceeded to the trial phase. In this stage, the researchers implemented the learning model into the lecture process. The following is a summary of the PBLG lesson plan for the Basic Concepts of Matter, Energy, and the Universe course.

Table 5. PBLG Syntax

Meeting	PBL Syntax	Core Lecturer & Student Activity
(Synchronous/ Face-to-Face)	1. Orienting students to the problem	The lecturer presents a scenario (energy crisis storytelling). Students analyze the problem and discuss energy wastage.
	2. Organizing students	The lecturer assists in forming "Energy Consultant" groups. Groups formulate the main problem (sources of energy wastage).
	3. Guiding independent/group investigation	The lecturer provides an information kit. Students develop an investigation plan for asynchronous data collection.
(Asynchronous /Independent)	4. Developing and presenting artifacts/work	Students conduct field investigation, analyze data, and create a video presentation of practical solutions.
	5. Analyzing and evaluating the process	The lecturer monitors and provides feedback. Students are required to watch and provide constructive feedback (peer assessment) on other groups' work.

Following the validation and refinement of the syntax, the PBLG model was formally implemented in the trial phase. The implementation was structured as a condensed blended learning intervention conducted over five distinct sessions, balancing synchronous (face-to-face) and asynchronous (independent) learning pathways as outlined in Table 5. During these sessions, the prospective teachers were actively immersed in simulated teaching scenarios. For instance, during the synchronous problem orientation and organization phases (Meetings 1–3), the instructional focus was placed heavily on developing the candidates' pedagogical skills, specifically in facilitating learning and guiding students through collaborative problem-solving. The science-based scenarios, such as the energy crisis storytelling, served as the contextual environment where prospective teachers practiced crucial teachers' classroom activities, including scaffolding group work and managing classroom dynamics.

Evaluation

In the evaluation phase, prospective elementary Islamic school (Madrasah Ibtidaiyah) teachers provided comprehensive feedback regarding their experience with the PBLG model across five core pedagogical dimensions. As detailed in Table 6, the descriptive analysis of the student responses demonstrated an overall average score of 4.46 (Very High) on a 1–5 Likert scale. Notably, the highest score was achieved in "Satisfaction with the Learning Model" (4.55), followed closely by "Learning Engagement and Motivation" (4.50) and "Attractiveness of Gamification Activities" (4.47). These exceptionally positive responses indicate that integrating gamification elements, such as structured levels, performance badges, and immediate reward loops, into the PBL syntax creates a highly motivating and empowering learning atmosphere (Alsadoon et al., 2022; Ghani et al., 2022).

Table 6. Student Responses to PBL Gamification

No	Assessed Aspect	Average Score	Category
1.	Learning Engagement and Motivation	4.50	Very High
2.	Attractiveness of Gamification Activities	4.47	Very High
3.	Understanding of the Material	4.36	High
4.	Team Collaboration and Interaction	4.40	Very High
5.	Satisfaction with the Learning Model	4.55	Very High
Overall Average	4.46	Very High	

Table 6 shown the high ratings in "Team Collaboration and Interaction" (4.40) and "Understanding of the Material" (4.36) underscore the model's effectiveness in enhancing actual teaching competencies. Prospective teachers reported that the gamified challenges forced them to transition from passive listeners to active facilitators, significantly boosting their confidence in guiding student investigations and conducting peer assessments (Čubela et al., 2023; Fonseca et al., 2023). This outcome reinforces the core objective of the PBLG model: ensuring that prospective educators do not merely memorize teaching theories but actively master the practical mechanics of classroom facilitation.

Furthermore, the success of this model in cultivating advanced pedagogical fluency among Madrasah Ibtidaiyah teacher candidates aligns closely with modern educational paradigms. Contemporary research in Islamic elementary education continuously emphasizes that integrating structured technology and active learning models is paramount to improving teacher professional competence and classroom adaptability (Kuncahyono, 2018; Wardani et al., 2023). By mapping gamified rewards directly to the execution of teaching tasks, the PBLG model successfully addresses this necessity, offering a scalable and innovative framework for modern teacher preparation programs

Descriptive analysis of the student response questionnaire indicated that, overall, the implementation of the Problem-Based Learning based gamification model received a very positive response from the participants. Studies show that gamification in higher education is effective in increasing student motivation and engagement in learning (Nadeem, 2020), and can significantly improve motivation and academic achievement. The overall average score fell into the very high category, with an average score above 4.20 on a 1–5 Likert scale. This indicates that students felt that learning with the PBL approach integrated with gamification elements provided a more engaging, interactive, and meaningful learning experience compared to conventional learning models (Huang et al., 2023; Wulan et al., 2024). The implementation of gamification, especially in the PBL context, has proven to be a promising strategy for enhancing student engagement, motivation, and knowledge acquisition (Čubela et al., 2023; Suartama et al., 2019). Furthermore, gamification can promote collaborative learning (Fonseca et al., 2023) and aid the development of problem-solving skills and academic performance.

When viewed by each aspect, student responses to learning engagement and motivation showed the very high category. Students felt more enthusiastic and active during the learning process due to the game elements, such as points, levels, and challenges, which encouraged the drive to complete problem-based tasks (Čubela et al., 2023; Duterte, 2024; Wulan et al., 2024). The integration of these gamification elements is proven to significantly increase student motivation and active participation (Mao & Lucas, 2024; Mitchell & Co, 2024). The attractiveness of gamification activities aspect also obtained a very high score, suggesting that the game elements integrated into learning succeeded in boosting students' enjoyment and emotional involvement in the learning activities (David & Weinstein, 2023; Ghani et al., 2022; Yu et al., 2020).

Furthermore, the understanding of the material aspect showed a high average score. This implies that the implementation of PBL Gamification not only increased learning interest but also helped students understand concepts more deeply through the context of real-world problem-solving (Boom-Cárcamo et al., 2024; Čubela et al., 2023; Kladchuen & Srisomphan, 2021). The combination of Problem-Based Learning and gamification significantly improves problem-solving abilities and student knowledge acquisition (Boom-Cárcamo et al., 2024; Čubela et al., 2023). Moreover, this approach is proven effective in improving student learning outcomes, experience, and motivation (Huang et al., 2023). The collaboration and interaction among students aspect also fell into the very high category. Students assessed that collaborative group learning with gamified challenges fostered better cooperation, enhanced communication, and cultivated a sense of shared responsibility in solving the given problems (Fonseca et al., 2023; Park & Kim, 2019; Vuillaume et al., 2021). Gamified learning environments with collaborative learning help students complete tasks by focusing on teamwork and social skill learning (Zheng & Wang, 2023). The design and execution of cooperative strategy games can also teach team leadership skills, including communication and conflict management (Lebrón et al., 2024).

Additionally, the satisfaction with the learning process aspect obtained the highest score among all indicators. Students felt satisfied with the learning experience which was enjoyable, challenging, and provided them with opportunities for active participation (Chong, 2019; Errabti et al., 2024; Murillo-Zamorano et al., 2021). Overall, these findings demonstrate that the implementation of the Problem-Based Learning based gamification model is capable of creating a positive and motivating learning atmosphere (Alsadoon et al., 2022; Ghani et al., 2022; Shojaei et al., 2022), as well as supporting the optimal achievement of learning objectives (Boom-Cárcamo et al., 2024; Feng et al., 2024; Huang et al., 2023).

CONCLUSION

This study addressed a critical pedagogical gap in teacher education: the persistent challenge prospective teachers face when translating theoretical knowledge into dynamic, real-world classroom facilitation. By systematically designing and validating the Problem-Based Learning Gamification (PBLG) model, this research provides an actionable solution to this hurdle. The findings confirm that the PBLG model is theoretically sound and structurally robust, as evidenced by a highly valid expert assessment score (98.12%). More importantly, the direct integration of gamification mechanics—such as points, levels, and challenges—into the PBL syntax yielded exceptionally positive practical outcomes (an overall effectiveness score of 4.46 out of 5). The model significantly amplified intrinsic motivation, peer collaboration, and overall satisfaction, successfully deepening concept comprehension without introducing anomalous educational side effects.

The implications of these findings offer a substantive contribution to higher education, particularly within teacher preparation programs. Rather than merely serving as an engagement tool, the PBLG model functions as a scalable instructional framework that equips prospective teachers with advanced pedagogical fluency. By simulating a gamified, problem-based environment, the structural scaffolding of this model transforms traditional problem-solving tasks into an interactive experience. This approach not only fosters learner autonomy but also cultivates the proactive facilitation competencies required to manage modern, dynamic classroom environments effectively.

Despite its promising outcomes, this study acknowledges certain methodological constraints, primarily its limited sample size and specific institutional context within Islamic elementary teacher education. To validate these initial results, future studies must examine the PBLG model across larger sample sizes and diverse institutional contexts. Expanding the implementation to other academic disciplines will clarify the model's true adaptability. Ultimately, the PBLG model offers a practical framework to modernize teacher preparation, successfully aligning pedagogical training with the current demand for engaging and self-directed learning.

REFERENCES

- Aini, D., Latifah, S., & Hamid, A. (2021). Problem Based Learning (PBL) Model: Its Effect in Improving Students' Critical Thinking Skill. *Indonesian Journal of Science and Mathematics Education*, 4(2), 183. <https://doi.org/10.24042/ijsme.v4i2.8660>
- Al-Hafdi, F. S., & Alhalafawy, W. S. (2024). Ten Years of Gamification-Based Learning: A Bibliometric Analysis and Systematic Review. *International Journal of Interactive Mobile Technologies (ijIM)*, 18(7), 188–212. <https://doi.org/10.3991/ijim.v18i07.45335>
- Alsadoon, E., Alkhawajah, A., & Suhaim, A. B. (2022). Effects of a gamified learning environment on students' achievement, motivations, and satisfaction. *Heliyon*, 8(8). <https://doi.org/10.1016/j.heliyon.2022.e10249>
- Anazifa, R. D., & Djukri, D. (2017). Project- Based Learning and Problem-Based Learning: Are They Effective to Improve Student's Thinking Skills? *Jurnal Pendidikan IPA Indonesia*, 6(2), 346–346. <https://doi.org/10.15294/jpii.v6i2.11100>
- Anthony, B., Kamaludin, A., Romli, A., Raffei, A. F. M., Phon, D. N. E., Abdullah, A., & Ming, G. L. (2020). Blended Learning Adoption and Implementation in Higher Education: A Theoretical and Systematic Review. *Technology Knowledge and Learning*, 27(2), 531–578. <https://doi.org/10.1007/s10758-020-09477-z>
- Boom-Cárcamo, E., Buelvas-Gutiérrez, L., Acosta-Oñate, L., & Boom-Cárcamo, D. (2024). Gamification and problem-based learning (PBL): Development of creativity in the teaching-learning process of mathematics in university students. *Thinking Skills and Creativity*, 53, 101614.
- Branch, R. M., & Varank, Í. (2009). *Instructional design: The ADDIE approach* (Vol. 722). Springer.
- Chan, S., & Lo, N. (2024). Enhancing EFL/ESL instruction through gamification: A comprehensive review of empirical evidence [Review of Enhancing EFL/ESL instruction through gamification: A comprehensive review of empirical evidence]. *Frontiers in Education*, 9. <https://doi.org/10.3389/feduc.2024.1395155>
- Chong, D. Y. K. (2019). Benefits and challenges with gamified multi-media physiotherapy case studies: A mixed method study. *Archives of Physiotherapy*, 9(1). <https://doi.org/10.1186/s40945-019-0059-2>
- Chuang, S. (2009). A study of developing project-based STEM learning activity. ... *Master's Thesis. Taiwan: National Kaohsiung Normal ...*, (Query date: 2020-10-22 13:53:28).
- Čubela, D., Rössner, A., & Neis, P. (2023). Using Problem-Based Learning and Gamification as a Catalyst for Student Engagement in Data-Driven Engineering Education: A Report. *Education Sciences*, 13(12), 1223. <https://doi.org/10.3390/educsci13121223>
- David, L., & Weinstein, N. (2023). A Gamified Experiential Learning Intervention for Engaging Students Through Satisfying Needs. *Journal of Educational Technology Systems*, 52(1), 52. <https://doi.org/10.1177/00472395231174614>
- Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review [Review of Gamifying education: What is known, what is believed and what remains uncertain: A critical review]. *International Journal of Educational Technology in Higher Education*, 14(1). <https://doi.org/10.1186/s41239-017-0042-5>

- Duterte, J. P. (2024). The Impact of Educational Gamification on Student Learning Outcomes. *International Journal of Research and Innovation in Social Science*, 477. <https://doi.org/10.47772/ijriss.2024.8100040>
- Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: The new normal and emerging technologies. *International Journal of Educational Technology in Higher Education*, 15(1), 3.
- Errabti, S., Zawiyah, Y., & Atia, A. (2024). Students' Satisfaction with Problem-Based Learning: An Academic Experience at International Maaref University. *Research Square (Research Square)*. <https://doi.org/10.21203/rs.3.rs-5251584/v1>
- Feng, J., Tan, W. H., & Yu, B. (2024). A systematic literature review of the impact of gamification instruction on students' problem-solving skills. *International Journal of Evaluation and Research in Education (IJERE)*, 13(6), 4082. <https://doi.org/10.11591/ijere.v13i6.29695>
- Fonseca, I., Caviedes, M., CHANTRÉ, J., & Bernate, J. (2023). Gamification and Game-Based Learning as Cooperative Learning Tools: A Systematic Review [Review of Gamification and Game-Based Learning as Cooperative Learning Tools: A Systematic Review]. *International Journal of Emerging Technologies in Learning (ijET)*, 18(21), 4. <https://doi.org/10.3991/ijet.v18i21.40035>
- García-López, I. M., Gonzaga, E. A., & Ledesma, E. F. R. (2023). Investigating the Impact of Gamification on Student Motivation, Engagement, and Performance. *Education Sciences*, 13(8), 813. <https://doi.org/10.3390/educsci13080813>
- Ghani, A. S. A., Rahim, A. F. A., Yusoff, M. S. B., & Hadie, S. N. H. (2022). Developing an interactive PBL environment via persuasive gamify elements: A scoping review [Review of Developing an interactive PBL environment via persuasive gamify elements: A scoping review]. *Research and Practice in Technology Enhanced Learning*, 17(1). <https://doi.org/10.1186/s41039-022-00193-z>
- Guerra, A., Rodríguez, F. J., Kolmos, A., & Reyes, I. P. (2017). PBL, Social Progress and Sustainability. In *Research Portal Denmark. Technical University of Denmark*. <https://local.forskningportal.dk/local/dki-cgi/ws/cris-link?src=aau&id=aau-ebf6ffeb-220d-447a-9303-6a93f6633066&ti=PBL%2C%20Social%20Progress%20and%20Sustainability>
- Gutiérrez, R. C., & López, J. M. S. (2016). Game-based learning and gamification in initial teacher training in the social sciences: An experiment with MinecraftEdu. *International Journal of Educational Technology in Higher Education*, 13(1). <https://doi.org/10.1186/s41239-016-0003-4>
- Henriksen, L. B. (2015). "Are they ready?": The technical high school as a preparation for engineering studies. *Research Portal Denmark*, 517.
- Huang, Y.-M., Silitonga, L. M., Murti, A. T., & Wu, T.-T. (2023). Learner Engagement in a Business Simulation Game: Impact on Higher-Order Thinking Skills. *Journal of Educational Computing Research*, 61(1), 96–126. <https://doi.org/10.1177/07356331221106918>
- Ibrahim, M. M., & Nat, M. (2019). Blended learning motivation model for instructors in higher education institutions. *International Journal of Educational Technology in Higher Education*, 16(1). <https://doi.org/10.1186/s41239-019-0145-2>

- Ishak, S. (2022). *ANALISIS PROBLEMATIKA PEMBELAJARAN DARING DI MASA PANDEMI KELAS IV A DI SD MUHAMMADIYAH 08 DAU MALANG*. Universitas Muhammadiyah Malang.
- Ishaq, M., Abid, K., Farooq, U., Ishaq, K., Satar, N. S. M., & Abid, A. (2025). A Framework for Designing Courses by Synergizing Project-Based Learning With Gamification. *Human Behavior and Emerging Technologies*, 2025(1). <https://doi.org/10.1155/hbe2/9915839>
- Isnayah, M., & Iswatiningsih, D. (2025). Teachers' Perceptions of the Application of Digital Gamification-Based Problem-Based Learning (PBL) to Increase Student Engagement. *DIDAKTIKA Jurnal Kependidikan*, 19(2), 163–174. <https://doi.org/10.30863/didaktika.v19i02.10787>
- Jaramillo-Mediavilla, L., Basantes-Andrade, A., González, M. C., & Martín, S. C. (2024). Impact of Gamification on Motivation and Academic Performance: A Systematic Review [Review of Impact of Gamification on Motivation and Academic Performance: A Systematic Review]. *Education Sciences*, 14(6), 639. <https://doi.org/10.3390/educsci14060639>
- Jensen, C. G., Ryberg, T., Bertel, L. B., & Dau, S. (2021). Authentic and ipsative assessment as a new approach to assessing PBL with a specific focus on experiential collaborative learning (ECL). *Research Portal Denmark*, 2021, 163.
- Jumadi, J., Perdana, R., Riwayani, R., & Rosana, D. (2021). The impact of problem-based learning with argument mapping and online laboratory on scientific argumentation skill. *International Journal of Evaluation and Research in Education (IJERE)*, 10(1), 16. <https://doi.org/10.11591/ijere.v10i1.20593>
- Kaur, V., Singh, J., Singh, J. P., & Kaur, P. (2025). Gamification in Teacher Education: Enhancing Engagement and Learning Outcomes of B.Ed Students. *International Journal For Multidisciplinary Research*, 7(4). <https://doi.org/10.36948/ijfmr.2025.v07i04.54293>
- Keane, E., Heinz, M., & Lynch, A. (2022). Factors impacting on the retention of students from under-represented groups in initial teacher education in Ireland. *Tertiary Education and Management*, 29(1), 5–23. <https://doi.org/10.1007/s11233-022-09108-5>
- Khaldi, A., Bouzidi, R., & Nader, F. (2023). Gamification of e-learning in higher education: A systematic literature review [Review of Gamification of e-learning in higher education: A systematic literature review]. *Smart Learning Environments*, 10(1), 10. <https://doi.org/10.1186/s40561-023-00227-z>
- Kim, J. G., & Sakir, N. A. I. (2020). Enhancing Students' Learning Activity and Outcomes via Implementation of Problem-based Learning. *Eurasia Journal of Mathematics Science and Technology Education*, 16(12). <https://doi.org/10.29333/ejmste/9344>
- Kladchuen, R., & Srisomphan, J. (2021). The synthesis of a model of problem-based learning with the gamification concept to enhance the problem-solving skills for high vocational certificate. *International Journal of Emerging Technologies in Learning (Online)*, 16(14), 4.
- Klock, A. C. T., Cunha, L. F. da, Carvalho, M. F. de, Rosa, B. E., Anton, A. J., & Gasparini, I. (2015). Gamification in e-Learning Systems: A Conceptual Model to Engage Students and Its Application in an Adaptive e-Learning System. In *Lecture notes in computer science* (p. 595). Springer Science+Business Media. https://doi.org/10.1007/978-3-319-20609-7_56

- Kofoed, L. B., Kristensen, N. S., Andreasen, L. B., Bruun-Pedersen, J. R., & Høeg, E. R. (2018). Integrating Courses and Project Work to support PBL: a conceptual design for changing curriculum structure. *Research Portal Denmark*, 260.
- Kuncahyono, K. (2018). Pengembangan E-Modul (Modul Digital) Dalam Pembelajaran Tematik di Sekolah Dasar. *JMIE (Journal of Madrasah Ibtidaiyah Education)*, 2(2), 219–231. <https://doi.org/10.32934/jmie.v2i2.75>
- Lebrón, M. J., Swab, R. G., & Bruns, R. (2024). Students as game designers and developers: Developing cooperative strategy board games to teach team leadership skills. *Organization Management Journal*, 21(1), 41. <https://doi.org/10.1108/omj-03-2023-1783>
- Li, M., Ma, S., & Shi, Y. (2023). Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: A meta-analysis [Review of Examining the effectiveness of gamification as a tool promoting teaching and learning in educational settings: A meta-analysis]. *Frontiers in Psychology*, 14. <https://doi.org/10.3389/fpsyg.2023.1253549>
- Mao, J., & Lucas, T. (2024). Gamification elements and their impacts on education: A review [Review of Gamification elements and their impacts on education: A review]. *Multidisciplinary Reviews*, 8(5), 2025155. <https://doi.org/10.31893/multirev.2025155>
- Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis*. sage.
- Mitchell, B., & Co, M. J. (2024). *The impact of Implementing Gamification Elements on Motivation, Engagement and Academic Achievement*. 1(1), 175. <https://doi.org/10.34190/icer.1.1.3113>
- Murillo-Zamorano, L. R., Sánchez, J. Á. L., Godoy-Caballero, A. L., & Muñoz, C. B. (2021). Gamification and active learning in higher education: Is it possible to match digital society, academia and students' interests? *International Journal of Educational Technology in Higher Education*, 18(1). <https://doi.org/10.1186/s41239-021-00249-y>
- Mustakim, S. S., Sulaiman, T., Lei, X., & Zou, Y. (2024). Promoting High-Order Thinking Skills through Problem-Based Learning: Design and Implementation. *International Journal of Academic Research in Progressive Education and Development*, 13(3). <https://doi.org/10.6007/ijarped/v13-i3/21697>
- Nadeem, M. (2020). AR-LaBOR: Design and assessment of an augmented reality application for lab orientation. In *Education Sciences* (Vol. 10, Issue 11, pp. 1–30). <https://doi.org/10.3390/educsci10110316>
- Nova, N., Kuswandi, D., & Syafi'udin, H. (2020). *Enhancing Mastery of Eco-Pedagogy for Sub-Urban Children by Gamification on Problem Based Learning*. <https://doi.org/10.2991/assehr.k.201214.242>
- Pařová, D., & Vejačka, M. (2022). Implementation of Gamification Principles into Higher Education. *European Journal of Educational Research*, 763. <https://doi.org/10.12973/eu-jer.11.2.763>
- Panis, I. C., Setyosari, P., Kuswandi, D., & Yuliati, L. (2020). Design Gamification Models in Higher Education: A Study in Indonesia. *International Journal of Emerging Technologies in Learning (IJET)*, 15(12), 244. <https://doi.org/10.3991/ijet.v15i12.13965>
- Papathoechari, T., Koutsopoulou, A., Moloni, P., & Niavis, S. (2024). *Strategic Innovative Marketing and Tourism*. Springer International Publishing. <https://doi.org/10.1007/978-3-031-51038-0>

- Papp, T. A. (2017). Gamification Effects on Motivation and Learning: Application to Primary and College Students. *International Journal for Cross-Disciplinary Subjects in Education*, 8(3), 3193–3201. <https://doi.org/10.20533/ijcdse.2042.6364.2017.0428>
- Park, S., & Kim, S. (2019). A Badge Design Framework for a Gamified Learning Environment: Cases Analysis and Literature Review for Badge Design. *JMIR Serious Games*, 7(2). <https://doi.org/10.2196/14342>
- Poluru, N. V. (2024). Enhancing Student Authenticity and Engagement Through Gamification and Problem-Based Learning in Higher Education. In *Advances in media, entertainment and the arts (AMEA) book series* (pp. 29–52). IGI Global. <https://doi.org/10.4018/979-8-3693-8322-3.ch002>
- Prahanı, B. K., Jatmiko, B., Hariadi, B., Sunarto, D., Sagirani, T., Amelia, T., & Lemantara, J. (2020). Blended Web Mobile Learning (BWML) Model to Improve Students' Higher Order Thinking Skills. *International Journal of Emerging Technologies in Learning (ijET)*, 15(11), 42–42. <https://doi.org/10.3991/ijet.v15i11.12853>
- Ramsaroop, S., Mahase, M. F., & Petersen, N. (2024). Bridging the theory-practice divide: Reflections of school-based student teachers. *South African Journal of Childhood Education*, 14(1). <https://doi.org/10.4102/sajce.v14i1.1558>
- Remojo, J. A. B., & Cacho, R. M. (2025). Balancing acts. *Journal of Interdisciplinary Studies in Education*, 15(1), 73–94. <https://doi.org/10.32674/9j37bh77>
- Runnerstrom, M. G., Denaro, K., & DiVincenzo, J. (2024). Exploring the Impact of Gamified Role-Playing on Climate Change Knowledge and Nature Relatedness: Evidence from an Online Undergraduate Course on Environmental Health. *Sustainability*, 16(11), 4484. <https://doi.org/10.3390/su16114484>
- Shojaei, A., Feili, A., Kojuri, J., Norafshan, A., & Bazrafkan, L. (2022). The blacksmith approach: A strategy for teaching and learning in the medical anatomy course (a qualitative study). *BMC Medical Education*, 22(1). <https://doi.org/10.1186/s12909-022-03800-1>
- Smith, K., Maynard, N., Berry, A., Stephenson, T., Spiteri, T., Corrigan, D., Mansfield, J., Ellerton, P., & Smith, T. (2022). Principles of Problem-Based Learning (PBL) in STEM Education: Using Expert Wisdom and Research to Frame Educational Practice. *Education Sciences*, 12(10), 728–728. <https://doi.org/10.3390/educsci12100728>
- Suartama, I. K., Setyosari, P., & Ulfa, S. (2019). Development of an instructional design model for mobile blended learning in higher education. *International Journal of Emerging Technologies in Learning*, 14(16).
- Syafi'udin, H., Nova, & Kuswandi, D. (2020). *Problem-Based Learning with the Gamification Approach in Ecopedagogy for Children Aged 4–7 Years: A Case Study of Kampung Kramat Malang, Indonesia*. <https://doi.org/10.2991/assehr.k.200214.015>
- Thomas, I. (2009). Critical Thinking, Transformative Learning, Sustainable Education, and Problem-Based Learning in Universities. *Journal of Transformative Education*, 7(3), 245. <https://doi.org/10.1177/1541344610385753>
- Torres, M. del R. M., Toral, S. L., García, F. B., Vázquez, S., Oliva, M. A., & Torres, T. P. (2006). A technological acceptance of e-learning tools used in practical and laboratory teaching,

- according to the European higher education area. *Behaviour and Information Technology*, 27(6), 495–505. <https://doi.org/10.1080/01449290600958965>
- Varadharajan, M., Buchanan, J., & Schuck, S. (2019). Navigating and negotiating: Career changers in teacher education programmes. *Asia-Pacific Journal of Teacher Education*, 48(5), 477–490. <https://doi.org/10.1080/1359866x.2019.1669136>
- Vuillaume, L. A., Laudren, G., Bosio, A., Thévenot, P., Pelaccia, T., & Chauvin, A. (2021). A Didactic Escape Game for Emergency Medicine Aimed at Learning to Work as a Team and Making Diagnoses: Methodology for Game Development. *JMIR Serious Games*, 9(3). <https://doi.org/10.2196/27291>
- Wardani, R. P., Fitriyah, C. Z., & Ningsih, Y. F. (2023). Kompetensi Pedagogik Guru Sekolah Dasar Program Pendidikan Profesi Guru dalam Pembelajaran. *JMIE (Journal of Madrasah Ibtidaiyah Education)*, 7(1), 1–10. <https://doi.org/10.32934/jmie.v7i1.404>
- Wijnia, L. (2024). The Effects of Problem-Based, Project-Based, and Case-Based Learning on Students' Motivation: A Meta-Analysis. In *Educational Psychology Review* (Vol. 36, Issue 1). <https://doi.org/10.1007/s10648-024-09864-3>
- Wulan, D. R., Nainggolan, D. E., Hidayat, Y., Rohman, T., & Fiyul, A. Y. (2024). Exploring the Benefits and Challenges of Gamification in Enhancing Student Learning Outcomes. *Global International Journal of Innovative Research*, 2(7), 1657. <https://doi.org/10.59613/global.v2i7.238>
- Yanto, F. (2019). Development of problem-based student worksheet with authentic assessment to improve student's physics problem solving ability. *Journal of Physics Conference Series*, 1185, 12075. <https://doi.org/10.1088/1742-6596/1185/1/012075>
- Yu, Z., Ming-le, G., & Wang, L. (2020). The Effect of Educational Games on Learning Outcomes, Student Motivation, Engagement and Satisfaction. *Journal of Educational Computing Research*, 59(3), 522. <https://doi.org/10.1177/0735633120969214>
- Yuliati, E., Rujianto, E., & Karyono, G. (2026). The mediating role of learning motivation: An integrated TAM2 and self-determination theory model for e-learning achievement. *ASATIZA Jurnal Pendidikan*, 7(1), 109–130. <https://doi.org/10.46963/asatiza.v7i1.3572>
- Zhang, S., Zhao, J., & Tan, W. (2008). Extending TAM for online learning systems: An intrinsic motivation perspective. *Tsinghua Science & Technology*, 13(3), 312–317. [https://doi.org/10.1016/s1007-0214\(08\)70050-6](https://doi.org/10.1016/s1007-0214(08)70050-6)
- Zheng, E., & Wang, Q. (2023). Effectiveness of Online Collaborative Learning in Gamified Environments. *International Journal of Emerging Technologies in Learning (IJET)*, 18(17), 33. <https://doi.org/10.3991/ijet.v18i17.42851>