JKTP: Jurnal Kajian Teknologi Pendidikan
Vol. 9, No. 4, November 2026: 450-461
e-ISSN: 2615-8787
DOI: 10.17977/um038v9i42026p450-461
https://journal-fip.um.ac.id/index.php/jktp

MICROLEARNING DESIGN FRAMEWORK ASSISTED BY ARTIFICIAL INTELLIGENCE TO ENHANCE STUDENT LEARNING ENGAGEMENT

Ni Nyoman Parwati, I Gede Wawan Sudatha, Putu Buddhi Prameswara, I Wayan Sukra Warpala
Universitas Pendidikan Ganesha, Singaraja, Bali, Indonesia
Corresponding Author E-Mail: nyoman.parwati@undiksha.ac.id

Article History
Received: 27 September 2026, Accepted: 27 October 2026, ***Published: 11 November 2026***

Abstrak
Penelitian ini bertujuan mengidentifikasi kebutuhan desain microlearning, menentukan fitur kecerdasan artifisial yang relevan, dan mengembangkan kerangka desain pembelajaran untuk mendukung keterlibatan belajar. Penelitian pengembangan tahap konseptual dilakukan melalui analisis kebutuhan, kajian literatur, penyusunan kerangka, serta validasi ahli. Data dikumpulkan melalui angket, wawancara, dan observasi terhadap responden yang terdiri atas guru, dosen, siswa/mahasiswa, ahli teknologi pendidikan, dan ahli AI; lima ahli menilai rancangan kerangka desain pembelajaran. Data dianalisis secara deskriptif dan kualitatif. Hasil penelitian menunjukkan bahwa kebutuhan karakteristik microlearning secara keseluruhan bernilai valid dengan fleksibilitas akses pembelajaran menjadi aspek kebutuhan yang memiliki rata-rata tertinggi. Sementara itu, aspek fokus pada satu tujuan dalam pembelajaran mendapatkan kriteria valid meskipun rata-rata penilaian menunjukkan aspek terendah. Berkaitan dengan kebutuhan utama fitur kecerdasan buatan, aspek umpan balik instan menjadi aspek dengan kebutuhan yang rata-ratanya tertinggi sedangkan aspek chatbot pembelajaran dinilai sebagai kebutuhan yang memiliki rata-rata terendah. Pada satu sisi, Kerangka desain pembelajaran yang dihasilkan mencakup tujuan pembelajaran, desain microlearning, aktivitas interaktif, personalisasi AI, umpan balik dan rekomendasi AI, analitik pembelajaran, serta keterlibatan belajar dan pemantauan pendidik. Penilaian ahli terhadap kerangka dan kelayakan implementasi kerangka ini berada pada kategori sangat valid. Kerangka desain pembelajaran menyediakan dasar untuk pengembangan prototipe, meskipun pengaruhnya terhadap keterlibatan belajar masih perlu diuji melalui implementasi atau eksperimen.

Kata Kunci: microlearning; kecerdasan artifisial; keterlibatan belajar; personalisasi; desain pembelajaran

Abstract
This study aims to identify specific microlearning design needs, determine relevant artificial intelligence features, and develop a comprehensive learning design framework to actively support continuous learner engagement. The conceptual phase of this developmental research was carefully conducted through needs analysis, literature review, framework design, and expert validation. Data were collected via questionnaires, interviews, and observations involving respondents comprising teachers, instructors, students, educational technology experts, and artificial intelligence specialists. Five appointed experts critically evaluated the learning design framework. Data were analyzed descriptively and qualitatively. Results indicate that the overall needs for microlearning characteristics are completely valid, with learning access flexibility securing the highest average score. Meanwhile, focusing on a single learning objective met validity criteria despite its evaluation being the absolute lowest. Regarding artificial intelligence feature needs, instant feedback represents the highest requirement, whereas learning chatbots received the lowest average rating. The resulting learning design framework essentially encompasses learning objectives, microlearning design, interactive activities, AI personalization, feedback, recommendations, analytics, learner engagement, and educator monitoring. Expert evaluations of this framework and its implementation feasibility successfully achieved a highly valid status. This framework provides a strong foundation for developing prototypes, though engagement impacts still require testing through actual implementations or future experiments.

Keywords*: microlearning; artificial intelligence; student engagement; personalization; instructional design*

To cite this article:
Parwati, N. N., Sudatha, I. G. W., & Warpala, I. W. S. (2026). Microlearning design framework assisted by artificial intelligence to enhance student learning engagement. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *9*(4), 450–461. doi: 10.17977/um038v9i42026p450-461

INTRODUCTION

Learning engagement encompasses students' behavioral participation, interests and emotional experiences, as well as their cognitive efforts during the learning process. These three dimensions are essential for assessing the quality of digital learning experiences (De Bruijn-Smolders & Prinsen, 2024; Dubey et al., 2023). Learning engagement is associated with how students participate in activities, develop emotional responses to learning, and exert mental effort to understand the material. In the context of digital learning, engagement is particularly important because students' activities recorded on a platform do not necessarily reflect the depth of their understanding or the quality of their thinking processes. Previous studies showed that research on learning engagement still rely heavily on observable behavioral indicators, such as clicks and activity duration, whereas emotional and cognitive dimensions are not always adequately represented (Bergdahl et al., 2024). However, the availability of digital media alone does not guarantee that students will examine the learning materials, respond to assignments, or seek assistance when encountering difficulties.

Microlearning delivers instruction through short and focused units. A review by Taylor and Hung highlights variations in the formats and outcomes of microlearning, while McNeill and Fitch emphasize the need for comprehensive instructional components within concise learning units (McNeill & Fitch, 2023; Taylor & Hung, 2022). Another study also demonstrates the importance of monitoring activity in microlearning courses (Javorcik et al., 2023). Consistent with these findings, a systematic review by Alias and Abdul Razak (2023) identifies pedagogical design as an important aspect of microlearning implementation. Therefore, the characteristics of a short unit must be accompanied by considerations regarding learning objectives, activities, the presentation of material, and evaluation (Alias & Abdul Razak, 2023). Accordingly, simply shortening videos or dividing reading materials into smaller sections is insufficient to create meaningful learning experiences. Each microlearning unit needs to be designed with specific objectives, a proportionate content load, relevant activities, and mechanisms for assessing students' understanding. The alignment of these components is necessary to ensure that short learning sessions still provide students with opportunities to process information, apply knowledge, and receive feedback. Furthermore, the sequence in which units are presented should take into account students' progress in mastering the material and their learning needs.

Artificial intelligence (AI) enables content adaptation, the diagnosis of learning difficulties, and the provision of feedback based on learning traces. A review by Hwang et al. (2020) identifies personalization and decision support as the primary roles of AI in education, while also highlighting challenges related to data and implementation (Hwang et al., 2020). Research on generative AI highlights its potential to facilitate interaction while emphasizing the need for human oversight (Giannakos et al., 2025). Heung and Chiu's analysis associates the use of ChatGPT with student engagement. However, the findings on a specific technology cannot be directly generalized to the effects of all AI-based designs (Heung & Chiu, 2025). Broader evidence also indicates that the relationship between generative AI and learning engagement is multifaceted. A systematic review of 72 studies identified evidence of both engagement and disengagement in ChatGPT-assisted learning, with varying findings across behavioral, emotional, and cognitive dimensions (Deng et al., 2025). These findings suggest that the benefits of AI depend on how the technology is used and integrated into the learning process. In the context of microlearning, AI has the potential to support the selection of subsequent learning units, provide hints tailored to students' difficulties, generate formative questions, and deliver feedback relevant to students' responses. Nevertheless, AI-generated recommendations need to account for instructional objectives, information accuracy, student characteristics, and the learning context. Studies have also emphasized the importance of stakeholder involvement, human control, security, and trust in the design of learning analytics

systems and educational AI (Alfredo et al., 2024). Therefore, AI integration into microlearning needs to be designed as a mechanism for supporting instructional decision-making, while educators retain responsibility for reviewing and interpreting the available information and determining appropriate follow-up actions.

Several previous studies provide relevant context which some of the studies discussed on AI-assisted electronic book development: Farida's analysis of student engagement in project-based learning, and Sari's development of interactive worksheets for problem-solving (Farida et al., 2024; Nugrahani et al., 2023; Sari et al., 2024). These studies demonstrate the potential of interactive learning media but do not yet describe an adaptive microlearning cycle that connects learning objectives, activities, learning data, AI recommendations, and educator monitoring within a unified design framework. This gap is relevant to the findings of Bergdahl et al. (2024), who highlighted the challenges of using digital activity data to capture the multiple dimensions of learning engagement comprehensively. Nevertheless, the development of the microlearning framework has already been conducted in previous studies. Through a systematic review of 40 studies, Monib et al. (2025) proposed a microlearning design framework encompassing learner characteristics, design principles, and learning outcomes (Monib, Qazi, & Apong, 2025). Meanwhile, Alfredo et al. (2024) emphasized the importance of human control, stakeholder involvement, security, and trust in the design of learning analytics systems and AI in education (Alfredo et al., 2023). Building on these two reviews, this study focuses on formulating the relationships among microlearning pedagogical components, the three dimensions of learning engagement, the use of learning data to support AI-generated recommendations, and the role of educators within a unified design framework. The framework is developed based on user needs and evaluated by experts.

Based on these problems and research gaps, this study aims to describe the microlearning characteristics required by users, identify relevant AI features, and develop and assess the initial validity of an AI-assisted microlearning design framework. This study considers learning engagement a primary consideration in the design process, encompassing support for students' behavioral participation, emotional experiences, and cognitive efforts. To achieve these objectives, the framework is developed around the relationships among learning objectives, short learning units, learning activities, formative assessment, the use of learning data, AI-generated recommendations, and educator monitoring. User involvement and expert evaluation are expected to provide a basis for assessing the alignment of the framework components with learning needs and instructional design principles. In this study, initial validity refers to the assessment of the framework's conceptual quality and appropriateness based on the evaluation criteria employed. Therefore, these findings need to be distinguished from evidence of implementation effectiveness among students. In accordance with these limitations, the research questions focus on three aspects: (1) What microlearning characteristics do users need to support student learning engagement? (2) What AI features are relevant for integration into microlearning design based on these needs? and (3) What is the conceptual quality of the AI-assisted microlearning design framework based on expert evaluation? The findings of this study are expected to give conceptual and practical contributions to the development of more structured, adaptive, and engagement-oriented digital learning designs, while providing a foundation for further research examining the feasibility and effectiveness of the framework in authentic learning contexts.

METHOD

This study employed a research and development approach at the conceptual stage. The research procedure consisted of needs analysis, a literature review on microlearning, AI, and learning engagement, the formulation of a conceptual design, the development of a draft framework, expert

validation and group discussions, and design refinement. The study involved 100 respondents, comprising 25 teachers, 15 lecturers, 40 students (from secondary or higher education), 10 educational technology experts, and 10 information technology or artificial intelligence (AI) experts. Respondents were recruited using purposive sampling, in which participants were deliberately selected based on their relevance to the research objectives. Recruitment was conducted by purposely distributing questionnaires to university students considered to have the knowledge and capacity to respond to the questions and statements in the questionnaire. The other respondents were drawn from groups of teachers, lecturers, and experts relevant to the research field. In addition to the respondents involved in the needs analysis, five experts were recruited to evaluate the developed design framework. These experts had backgrounds in educational technology, instructional design, learning media, artificial intelligence, and digital learning. Their selection was based on their competencies and the relevance of their expertise to the aspects evaluated in the design framework. The evaluation aimed to obtain feedback on the appropriateness of the components, the relationships among components, and the conceptual quality of the developed framework.

Data were collected using a questionnaire that had been validated by three educational technology experts, all of whom rated every item as valid. In addition, limited interviews were conducted with selected respondents, and observations were made of teachers' instructional practices. The expert evaluation covered the alignment of objectives, microlearning concepts, AI integration, framework structure, relationships among components, potential to support learning engagement, implementation feasibility, and comprehensibility. Questionnaire and validation scores were summarized using means and predetermined categories. Qualitative data were synthesized through thematic grouping, interpretation, and cross-source comparison to guide framework refinement.

RESULT

The 100 respondents represented three groups: educators (40 respondents), students (40 respondents), and educational technology or IT/AI experts (20 respondents). The overall mean score for the ten microlearning characteristics was 4.53. Table 1 presents the scores for the instructional design characteristics, with anytime, anywhere access receiving the highest score (4.61), followed by mobile accessibility (4.58) and ease of use (4.57). User needs regarding microlearning characteristics and artificial intelligence features were assessed using a 5-point rating scale, ranging from 1 to 5. Higher scores indicate a greater level of need or priority assigned to the microlearning characteristics and AI features being evaluated. Table 1 presents the mean scores for all microlearning characteristics examined in this study. Presenting all indicators provides a comprehensive overview of user needs and enables readers to compare the priority levels assigned to each characteristic.

Table 1. Key Microlearning Characteristics Required by Users

Characteristics	Average
Access flexibility	4,61
Mobile accessibility	4,58
Simple and user-friendly design	4,57
Interesting multimedia	4,55
Direct feedback	4,54
Focused on a Single Learning Objective	4,52
Overall Average	**4,53**

The ten AI features obtained an overall mean score of 4.50. As shown in Table 2, immediate feedback (4.62) was identified as the highest-priority need, followed by content personalization (4.58) and the identification of learning difficulties (4.57). The chatbot feature received a score of 4.35, indicating that it should be positioned as a context-specific learning assistant rather than a

central feature guiding the entire design. Table 2 presents the mean scores for all artificial intelligence features examined in this study. Presenting all indicators highlights the features prioritized by users and provides a basis for selecting the AI features to be integrated into the design framework.

Table 2. Key AI Features Required by Users

AI Features	Average
Direct feedback	4,62
Personalized content	4,58
Identification of learning difficulties	4,57
Learning progress analysis	4,55
Adaptive learning pathway	4,51
Learning chatbot	4,35
Overall Average	**4,50**

Overall, these results indicate that users prioritize AI features that support feedback provision and learning adaptation based on students' needs. These findings serve as a basis for determining the AI functions to be incorporated into the design framework.

The synthesis of user needs and the literature review resulted in a sequential structure for each learning unit: an introductory prompt, learning objectives, concise content, interactive activities, a brief assessment, AI analysis, personalized feedback, and follow-up recommendations. At the system level, the seven components of the final framework are presented in Table 3. These components are interconnected in a cycle: learning objectives guide the design of units and activities; student responses provide data for analytics; analytical outputs inform content adaptation and recommendations; and educators monitor these outputs and students' engagement development.

Table 3. Components of the Final Design Framework

Component	Design Function
Learning objectives	Define competencies and indicators for each unit
Microlearning design	Present concise, focused, and accessible learning materials
Interactive learning	Provide brief learning activities and assessments
AI personalization	Adapt content based on individual needs
AI recommendation and feedback	Provide feedback and suggest subsequent steps
Learning analytics	Summarize learning activities and progress
Teachers involvement and monitoring	Analyze behavioral, emotional, and cognitive indicators while maintaining human oversight.

The five experts assigned an overall mean score of 4.63, indicating that the framework was classified as highly valid. Alignment with learning objectives and the potential to support learning engagement received the highest scores (4.72), while implementation feasibility received the lowest score (4.48). Expert feedback led to recommendations to clarify the sequence of learning units, specify data indicators for personalization, establish boundaries for chatbot outputs, simplify learning analytics, define learning engagement operationally, strengthen educator monitoring, and incorporate privacy principles. Figure 1 presents the developed conceptual framework for AI-assisted microlearning design. Based on the needs analysis and literature review, the design framework was developed by integrating learning objectives, microlearning design, interactive learning, AI-based personalization, AI-generated feedback and recommendations, learning analytics, and learning engagement and educator monitoring. This integration is intended to connect user needs with the design of learning units, the use of student response data, and the role of educators in monitoring the learning process. These seven components are presented in Table 3 and visualized in Figure 1.

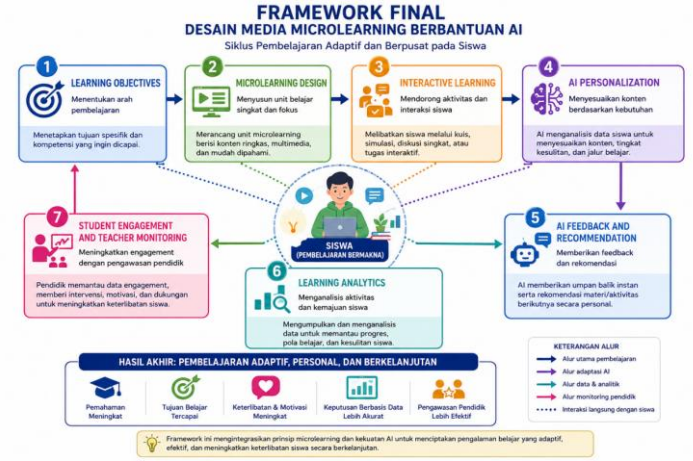


Figure 1. Conceptual Framework for AI-Assisted Microlearning Design

DISCUSSION

The high ratings for flexible and mobile access highlight the importance of designing learning units that can be accessed within short periods and on devices commonly owned by users. This finding is consistent with Javorcik et al. (2023), whose monitoring of microlearning activities indicates that mobile use can improve learning outcomes. Easy access needs to be accompanied by simple navigation, readable learning materials, and the ability to return to previous activities. If learning materials are merely divided into fragments without clear objectives and assessments, students may lose the connections between concepts.

To address the first research question, the findings indicate that microlearning needs to be designed by taking into account the characteristics required by users to support student learning engagement. The resulting instructional design principles comprise five characteristics: focused, concise, interactive, flexible, and meaningful. These five principles are interconnected. Specific objectives determine the scope of the content; activities and brief quizzes transform content consumption into observable actions; and immediate feedback helps students identify areas for improvement. Taylor and Hung (2022) noted the heterogeneity of microlearning interventions, highlighting the need to describe the design of each learning unit in detail. McNeill and Fitch demonstrated that instructional events can still be incorporated into a concise format. Accordingly, the eight-stage structure proposed in this study provides an initial specification that can be tested and refined.

The second research question focuses on AI features relevant to supporting microlearning characteristics based on user needs. Priority on immediate feedback indicates that AI should be positioned after a student's learning response becomes available. Based on respondents' views, students' quiz responses, requests for clarification, and patterns of repeated engagement with learning materials can help the system identify their needs. Pedagogical rules can then guide the type of feedback or subsequent content provided. Hwang et al. (2020) highlighted the challenges related to data and the roles of AI in educational design, while Giannakos et al. (2025) also emphasized the importance of evaluating the quality and implications of generative AI outputs. Therefore, recommendations need to remain accessible for educators to review and correct.

The lower score on chatbot features compared with immediate feedback and personalization further emphasizes that feature selection should be guided by learning functions rather than technological popularity. Chatbots can guide students in seeking explanations or provide step-by-step hints. However, their responses may exceed the scope of a learning unit, contain inaccuracies, or provide solutions prematurely. Ifelebuegu et al. (2023) discussed both the benefits and risks of

educational chatbots. Within the proposed framework, chatbot functionality is therefore restricted to reviewed content and questions relevant to learning objectives, with a referral mechanism to educators when responses are uncertain.

Learning analytics serves two distinct functions. At the individual level, response data can help determine the appropriate level of subsequent support. At the classroom level, summaries of patterns in learning difficulties can help educators decide when a concept needs to be retaught. Both functions require operationally defined and interpretable indicators. For example, the number of times students access learning materials or complete quizzes may reflect behavioral engagement, but these indicators do not automatically measure emotional interest or cognitive processing. Assessing the three dimensions of learning engagement therefore requires different types of evidence to ensure that conclusions are not based on a single digital activity trace.

The third research question discusses the conceptual quality of the framework based on expert evaluation. The expert validation score of 4.63 supports the conceptual acceptability of the proposed design according to the evaluators. Based on the expert assessments, implementation feasibility received the lowest score (4.48). This difference helps establish priorities for the next development stage, including creating a prototype that explicitly demonstrates adaptation rules, preparing validated content and assessment answer keys, evaluating feedback quality, and ensuring that the interface is accessible across devices with varying capabilities. The potential to improve learning engagement, as assessed by experts, should not be equated with measurable changes in students' engagement.

The novelty of the framework lies in the integration of microlearning units, response data, AI-assisted adaptation, and educator oversight. Unlike AI-assisted electronic books examined in previous studies, the proposed design positions recommendations after micro-assessments within a recurring learning cycle. It also differs from Farida et al. (2024), who examined engagement in project-based learning, as the present study considers learning engagement an evaluation target of adaptive design. Meanwhile, the development of interactive worksheets by Sari et al. (2024) highlights the importance of learning products that can be tested within specific subject contexts.

Privacy and human oversight are essential design requirements that need to be considered from the outset. The data required to generate recommendations should be limited to relevant learning information, disclosed to users, and stored under clearly defined data governance practices. Educators should be able to review the rationale behind recommendations and reject outputs that are inappropriate.

The conceptual contribution of this framework lies in connecting microlearning pedagogical components, the three dimensions of learning engagement, student response data, AI-assisted recommendations, and the role of educators within a unified design process. The framework is designed to link student responses to learning recommendations that remain subject to educator review. Thus, the contribution of this study lies in integrating these components based on user needs and expert evaluation, rather than claiming that the framework has been proven to improve student learning engagement.

At the design stage, each microlearning unit should begin with a prompting question related to students' prior knowledge. The learning objective should be expressed as an assessable action that can be evaluated through a single activity or a short set of questions. The subsequent content should provide sufficient explanation for completing the activity without presenting the entire topic on a single screen. Micro-assessments need to be designed to identify meaningful errors, such as specific conceptual misconceptions, so that feedback can explain the reasons behind incorrect responses and

provide opportunities for students to try again. Previous research on misconception reduction provides context for the importance of error diagnosis; however, the proposed design still requires separate empirical testing using selected learning materials (Parwati & Suharta, 2020).

At the interaction stage, AI can use simple rules before more complex models are introduced. For example, a correct response accompanied by an appropriate explanation may direct students to the next unit, whereas an incorrect answer following a specific pattern may trigger a contrasting example and an opportunity to complete an equivalent question. Such decisions need to be recorded so that educators can understand why the system directs students along a particular learning path. If a student's answer is ambiguous, the system should request clarification rather than draw conclusions about the student's ability based on a single error. This approach is consistent with the development of microlearning systems that integrate interaction and collaboration (Garshasbi et al., 2021), while also reducing the risk of recommendations that cannot be explained.

At the evaluation stage, the quality of the framework can be assessed using multiple sources of evidence. Expert opinions provide evidence of design appropriateness, while limited trials provide evidence of whether students can use the interface and navigate the learning process. System logs can describe activity completion, but students' emotional perceptions need to be assessed directly, and their cognitive efforts need to be assessed through their work or explanations. Academic achievement should also be distinguished from student engagement. Research on learning environments and academic performance by Kassab et al. (2024), as well as a review of blended learning by De Bruijn-Smolders and Prinsen (2024), helps establish that these two outcomes are related but represent distinct constructs (De Bruijn-Smolders & Prinsen, 2024; Kassab et al., 2024).

Previous research in digital learning environments provides a rationale for testing the design across different contexts rather than assuming that a single format is universally applicable. Puniatmaja et al. (2024) examined e-learning and digital literacy (Puniatmaja et al., 2024). In addition, Parwati et al. (2025) investigated student-engagement-based HyFlex learning, while Ms et al. (2022) examined project-based e-learning in relation to cognitive and psychomotor outcomes. Differences in the objectives, learning groups, and outcomes of these studies indicate the need to determine when microlearning units are appropriate and when longer learning activities remain necessary. Student engagement may be influenced by task challenges, educator support, and technological readiness. Therefore, any changes observed following the future implementation of the prototype should be interpreted in light of the conditions under which it is implemented.

The availability of AI should not obscure the distinction between perceived personalization and personalization that actually works. Users may assign high need scores because they expect a more responsive learning experience, but these expectations do not specify which algorithms would be effective. Mallik and Gangopadhyay (2023) distinguish between proactive and reactive uses of AI, while Saputra et al. (2024) discuss deep learning-based personalization (Mallik & Gangopadhyay, 2023; Saputra et al., 2024). The conceptual framework for instructional media design developed in this study is intentionally open to various technical approaches, provided that the input data, decision rules, and feedback quality can be explained. The study by Vázquez-Cano (2021) and the theoretical discussion of TPACK by Parwati et al. (2023) underscore the importance of aligning technology choices with content and pedagogical strategies (Parwati et al., 2023; Vázquez-Cano, 2021).

Further research is needed to test this framework through prototype development and implementation in clearly defined learning contexts. Initial testing should assess prototype usability, the appropriateness of AI recommendations, feedback quality, and ease of use for both students and educators. Subsequent empirical research can examine learning engagement by measuring its behavioral, emotional, and cognitive dimensions separately. Such testing should account for

students' baseline conditions, subject characteristics, implementation duration, and implementation conditions. Accordingly, the expert validation results in this study should be interpreted as evidence of the framework's conceptual quality, whereas claims regarding its effectiveness require further empirical evidence.

The interface design should provide students with sufficient control to review the rationale behind each recommendation. For example, after completing a quiz, students should be able to see which learning objectives they have not yet achieved, which aspects of their responses need improvement, and whether they can revisit the material or request additional examples. If students choose a different learning path from the one suggested by the system, this choice can be recorded as a signal for further analysis rather than treated as noncompliance. Suartama et al. (2019) emphasized the design dimensions of mobile blended learning; similar considerations are important here to ensure that navigation between screens does not create additional barriers (Suartama et al., 2019). The analytics feature can provide educators with concise summaries without turning every student action into a permanent label. Data-use boundaries, retention periods, and the right to request corrections to recommendations need to be established during prototype development.

Defining learning engagement indicators for the prototype requires particular attention. Behavioral engagement can be examined through participation and task completion, but the time spent accessing a page does not necessarily indicate active learning. Emotional engagement can be measured through students' self-reports of interest, comfort, or frustration. These reports should be linked to the context of specific activities rather than assessed through a single general question. Cognitive engagement can be observed through students' explanations for their answers, strategies for correcting errors, and application of knowledge to new questions. Analyses of various studies help explain why engagement needs to be operationally defined according to the activities and learning environments involved. The three indicators may also change in different directions; for example, students may access learning content frequently without yet understanding the concepts. These differences are important for informing educators' decisions.

The lowest score for implementation feasibility in the expert validation also highlights several technical design priorities. Content needs to be prepared in formats that remain accessible under limited connectivity; AI responses need to be tested against correct, incorrect, and ambiguous answers; and activity logging must continue to function when students switch devices. When AI cannot generate adequate feedback, the system can display feedback prepared by educators. Reviews of AI in education by Mallik and Gangopadhyay (2023), Hwang et al. (2020), and Giannakos et al. (2025) highlight the need to assess its benefits and challenges simultaneously. Such documentation would allow researchers to distinguish limitations in the AI model from those in the learning materials, activities, or interface.

CONCLUSIONS

This study successfully developed an AI-assisted microlearning design framework based on user needs analysis, a literature review, and expert feedback. The needs analysis showed that users prioritized flexible learning access through mobile devices and immediate AI-generated feedback. Expert evaluations supported the conceptual quality of the framework as a basis for developing adaptive learning media that integrate pedagogical components, AI utilization, educator monitoring, and data protection. However, this study was limited to the conceptual stage and did not examine the framework's usability, implementation feasibility, or effects on student learning engagement. Therefore, future research should develop and test a prototype in authentic learning settings, evaluate the quality of AI outputs, and investigate potential changes in students' behavioral, emotional, and cognitive engagement.

ACKNOWLEDGEMENT

This study was supported by the 2026 Research and Development Grant Scheme for Research Groups, funded through the DIPA of Universitas Pendidikan Ganesha, under Contract No. 512/UN48.16/PT.01.03/2026. The authors would like to thank the respondents and experts for their valuable feedback on the learning media design framework.

REFERENCES

Alfredo, R., Echeverria, V., Jin, Y., Yan, L., Swiecki, Z., Gašević, D., & Martinez-Maldonado, R. (2024). Human-centred learning analytics and AI in education: A systematic literature review. *Computers and Education: Artificial Intelligence*, *6*, 100215. https://doi.org/10.1016/j.caeai.2024.100215

Alias, N. F., & Abdul Razak, R. (2023). Exploring the pedagogical aspects of microlearning in educational settings: A systematic literature review. *Malaysian Journal of Learning and Instruction*, *20*. https://doi.org/10.32890/mjli2023.20.2.3

Bergdahl, N., Bond, M., Sjöberg, J., Dougherty, M., & Oxley, E. (2024). Unpacking student engagement in higher education learning analytics: A systematic review. *International Journal of Educational Technology in Higher Education*, *21*(1), 63. https://doi.org/10.1186/s41239-024-00493-y

De Bruijn-Smolders, M., & Prinsen, F. R. (2024). Effective student engagement with blended learning: A systematic review. *Heliyon*, *10*(23), e39439. https://doi.org/10.1016/j.heliyon.2024.e39439

Deng, R., Jiang, M., Yu, X., Lu, Y., & Liu, S. (2025). Does ChatGPT enhance student learning? A systematic review and meta-analysis of experimental studies. *Computers & Education*, *227*, 105224. https://doi.org/10.1016/j.compedu.2024.105224

Dubey, P., Pradhan, R. L., & Sahu, K. K. (2023). Underlying factors of student engagement to E-learning. *Journal of Research in Innovative Teaching & Learning*, *16*(1), 17–36. https://doi.org/10.1108/JRIT-09-2022-0058

Farida, M. K., Setyosari, P., & Aulia, F. (2024). Analisis Keterlibatan Mahasiswa Dalam Pembelajaran Berbasis Proyek. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *7*(3), 172. https://doi.org/10.17977/um038v7i32024p172

Garshasbi, S., Yecies, B., & Shen, J. (2021). Microlearning and computer-supported collaborative learning: An agenda towards a comprehensive online learning system. *STEM Education*, *1*, 225. https://doi.org/10.3934/steme.2021016

Giannakos, M., Azevedo, R., Brusilovsky, P., Cukurova, M., Dimitriadis, Y., Hernandez-Leo, D., Järvelä, S., Mavrikis, M., & Rienties, B. (2025). The promise and challenges of generative AI in education. *Behaviour & Information Technology*, *44*(11), 2518–2544. https://doi.org/10.1080/0144929X.2024.2394886

Heung, Y. M. E., & Chiu, T. K. F. (2025). How ChatGPT impacts student engagement from a systematic review and meta-analysis study. *Computers and Education: Artificial Intelligence*, *8*, 100361. https://doi.org/10.1016/j.caeai.2025.100361

Hwang, G.-J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles and research issues of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence*, *1*, 100001. https://doi.org/10.1016/j.caeai.2020.100001

Ifelebuegu, A. O., Kuluma, P., & Cherukut, P. (2023). Chatbots and AI in Education (AIEd) tools: The good, the bad, and the ugly. *Journal of Applied Learning & Teaching*, *6*(2). https://doi.org/10.37074/jalt.2023.6.2.29

Javorcik, T., Kostolanyova, K., & Havlaskova, T. (2023). Microlearning in the Education of Future Teachers: Monitoring and Evaluating Students' Activity in a Microlearning Course. *Electronic Journal of E-Learning*, *21*(1), 13–25. https://doi.org/10.34190/ejel.21.1.2623

Kassab, S. E., Rathan, R., Taylor, D. C. M., & Hamdy, H. (2024). The impact of the educational environment on student engagement and academic performance in health professions education. *BMC Medical Education*, *24*(1), 1278. https://doi.org/10.1186/s12909-024-06270-9

Mallik, S., & Gangopadhyay, A. (2023). Proactive and reactive engagement of artificial intelligence methods for education: A review. *Frontiers in Artificial Intelligence*, *6*, 1151391. https://doi.org/10.3389/frai.2023.1151391

McNeill, L., & Fitch, D. (2023). Microlearning through the Lens of Gagne's Nine Events of Instruction: A Qualitative Study. *TechTrends*, *67*(3), 521–533. https://doi.org/10.1007/s11528-022-00805-x

Ms, G. D. T., Ni Nyoman, P., Warpala, I. W. S., Sudatha, I. G. W., Sudarmika, P., & Suartama, I. K. (2022). The impact of project based E-learning on cognitive and psychomotor learning achievement in sports massage course. *Cypriot Journal of Educational Sciences*, *17*(12), 4393–4408. https://doi.org/10.18844/cjes.v17i12.7913

Nugrahani, R. H., Kuswandi, D., & Wedi, A. (2023). Pengaruh Flipped Classroom Dan Literasi Digital Terhadap Penguasaan Konsep Sosiologi Materi Integrasi Sosial. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *6*(2), 120. https://doi.org/10.17977/um038v6i22023p120

Parwati, N. N., Mariawan, I. M., & Suparta, I. N. (2019). The effectiveness of the implementation of environmental-based learning media toward the mathematical problem-solving ability and the impact on students' nationalism attitudes. *Journal of Physics: Conference Series*, *1317*, 012123. https://doi.org/10.1088/1742-6596/1317/1/012123

Parwati, N. N., & Suharta, I. G. P. (2020). Effectiveness of the implementation of cognitive conflict strategy assisted by e-service learning to reduce students' mathematical misconceptions. *International Journal of Emerging Technologies in Learning (iJET)*, *15*(11), 102–102. https://doi.org/10.3991/ijet.v15i11.11802

Parwati, N. N., Suharta, I. G. P., & Sudatha, I. G. W. (2023). TPACK Theoretical Correspondence with Learning Variables and Its Application Effectiveness in Learning. *Journal of Pedagogy and Education Science*, *2*(03), 244–256. https://doi.org/10.56741/jpes.v2i03.402

Parwati, N. N., Suharta, I. G. P., Sudatha, I. G. W., Prameswara, P. B., & Halili, S. H. (2025). Optimization student learning outcomes through hyflex learning based on student engagement. *Journal of Applied Science, Engineering, Technology, and Education*, *7*(3), 427–440. https://doi.org/10.35877/454RI.asci4134

Puniatmaja, G. A., Parwati, N. N., Tegeh, I. M., & Sudatha, I. G. W. (2024). The effect of e-learning and students' digital literacy towards their learning outcomes. *Pegem Journal of Education and Instruction*, *14*(1), 348–356. https://doi.org/10.47750/pegegog.14.01.39

Saputra, I. A., Ramadhani, A., Zahra Khairunnisa, M., & Ainiyah, D. N. (2024). Pengaruh literasi digital terhadap prestasi akademik siswa menengah atas. *Jurnal Ilmu Pendidikan Dan Pembelajaran*, *3*(1), 25–31. https://doi.org/10.58706/jipp

Sari, Y. P., Sinaga, M., & Hermandra, H. (2024). Pengembangan Modul Pembelajaran Teks Poster Bermuatan Budaya Melayu Riau Untuk Siswa Kelas VIII MTs. *JKTP: Jurnal Kajian Teknologi Pendidikan*, *7*(4), 238. https://doi.org/10.17977/um038v7i42024p238

Suartama, I. K., Setyosari, P., Sulthoni, S., & Ulfa, S. (2019). Development of an Instructional Design Model for Mobile Blended Learning in Higher Education. *International Journal of Emerging Technologies in Learning (iJET)*, *14*(16), 4. https://doi.org/10.3991/ijet.v14i16.10633

Supuwiningsih, N. N., Parwati, N. N., Suharta, I. G. P., & Tegeh, I. M. (2024). The Development of E-Learning Using Multimedia-Based GIS E-Modules. *Scaffolding: Jurnal Pendidikan Islam Dan Multikulturalisme*, *5*(2), 1049–1066. https://doi.org/10.37680/scaffolding.v5i2.3769

Taylor, A., & Hung, W. (2022). The Effects of Microlearning: A Scoping Review. *Educational Technology Research and Development*, *70*(2), 363–395. https://doi.org/10.1007/s11423-022-10084-1

Vázquez-Cano, E. (2021). Artificial intelligence and education: A pedagogical challenge for the 21st century. *Educational Process International Journal*, *10*(3). https://doi.org/10.22521/edupij.2021.103.1