



Development of an Interactive Artificial Intelligence Prompting E-Module for Self-Directed Learning in Senior High School Students

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ABSTRACT

The integration of Generative Artificial Intelligence into the national secondary education curriculum in Indonesia has created an urgent need for structured AI literacy resources. An initial needs analysis conducted among 10th grade students at a high school in Indonesia showed a high level of AI usage for academic purposes, yet encountered significant difficulties in constructing structured prompts and critically evaluating AI-generated outputs. This study aims to develop and assess the practicality of an interactive AI Prompting E-Module designed to support self-directed learning. This study employed a Research and Development (R&D) approach guided by the ADDIE model. The developed product is a flipbook-based interactive module that integrates ethical AI literacy content, structured prompting strategies via the R-T-C-F framework, and targeted reflective evaluation tasks. Expert validation involved one subject matter expert and one media expert, followed by a limited user trial with 35 tenth-grade students. Validation by the subject matter expert achieved a score of 90%, and validation by the media expert achieved 87.5%, both categorized as Very Feasible. The user trial resulted in an overall practicality score of 81.72%, which is categorized as Very Feasible, indicating that this module is interesting, easy to understand, and easy to use as a structured learning resource. This module serves as an instructional bridge that facilitates the translation of national AI curriculum competencies into classroom practice while fostering responsible and self-directed AI engagement in secondary education.

ABSTRAK

Integrasi Kecerdasan Buatan Generatif ke dalam kurikulum pendidikan menengah nasional di Indonesia telah menciptakan kebutuhan mendesak akan sumber daya literasi AI yang terstruktur. Analisis kebutuhan awal yang dilakukan pada sekelompok siswa kelas 10 di sebuah SMAN di Indonesia menunjukkan tingkat penggunaan AI yang tinggi untuk tujuan akademik, namun disertai kesulitan signifikan dalam pemberian prompt terstruktur dan evaluasi kritis terhadap output AI. Penelitian ini bertujuan untuk mengembangkan dan menilai kepraktisan E-Modul interaktif AI Prompting yang dirancang untuk mendukung pembelajaran mandiri. Penelitian ini menggunakan pendekatan Penelitian dan Pengembangan (R&D) dengan model ADDIE. Produk yang dikembangkan adalah modul interaktif berbasis flipbook yang berisikan materi literasi AI etis, strategi prompting terstruktur melalui kerangka kerja R-T-C-F, dan tugas evaluasi reflektif yang terarah. Validasi ahli melibatkan satu ahli materi dan satu ahli media, diikuti dengan uji coba pengguna terbatas dengan 35 siswa kelas 10. Validasi oleh ahli materi mencapai skor 90%, dan validasi oleh ahli media mencapai 87,5%, keduanya dikategorikan sebagai Sangat Layak. Uji coba pengguna menghasilkan skor kepraktisan keseluruhan sebesar 81,72%, dikategorikan sebagai Sangat Layak, yang mengonfirmasi keterbacaan dan kemudahan penggunaan modul sebagai sumber belajar terstruktur. Modul ini berfungsi sebagai alat penghubung yang mendukung penerapan kompetensi kurikulum AI nasional ke dalam praktik

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KEYWORDS

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pembelajaran di kelas sambil mendorong keterlibatan AI yang bertanggung jawab dan mandiri di kalangan siswa SMA di Indonesia.

INTRODUCTION

The twenty-first century is characterized by rapid technological transformation that reshapes social, economic, and educational systems. At the center of this transformation stands Artificial Intelligence (AI), which has evolved into one of the most influential technological forces in contemporary society (Isdayani et al., 2024). The integration of AI into educational environments reflects a broader global shift in which AI technologies are redefining instructional practices and learning processes (Holmes et al., 2022). In particular, recent developments in generative AI models have intensified AI adoption in academic activities such as information retrieval, content generation, and problem solving.

Within educational contexts, AI is increasingly positioned as a tool to support adaptive and personalized learning. AI-driven systems allow instructional content and learning pathways to be adjusted according to students' needs and pace. Ayeni et al. (2024) argue that AI integration can foster interactive and adaptive learning environments that enhance creativity and facilitate the understanding of complex concepts. These perspectives position AI not merely as an assistive technology, but as a pedagogical resource that requires structured literacy development.

Despite its potential benefits, scholarly discussions emphasize critical challenges associated with AI implementation in education. Research highlights concerns related to data privacy, algorithmic bias, misinformation, and reduced critical engagement when AI systems are used without sufficient guidance (Kasneji et al., 2023). Broader reviews of AI in educational research also caution that technological adoption without pedagogical scaffolding may lead to superficial engagement rather than meaningful learning (Zawacki-Richter et al., 2019). These concerns suggest that AI literacy must encompass ethical awareness, evaluative competence, and responsible engagement practices.

At the policy level, the Indonesian Ministry of Education has formally integrated AI literacy into the national curriculum through the Coding and Artificial Intelligence subject at the senior high school level (Kemendikbud, 2025). This initiative reflects a commitment to preparing students not only to utilize AI technologies, but also to understand their ethical and legal implications. However, while curriculum reform demonstrates institutional readiness, implementation at the classroom level remains in a transitional phase. Translating curriculum Learning Outcomes into structured, classroom-ready instructional practices continues to present pedagogical challenges.

A Preliminary needs analysis conducted among a cohort of Grade 10 students at a public senior high school in Indonesia indicates a high level of AI engagement. More than 85.1% of students reported prior experience using AI technologies. Specifically, 89.4% reported frequently using AI tools to complete school assignments, and 85.1% reported using AI to seek explanations of learning materials. Despite this high utilization, students commonly report difficulties in constructing effective prompts and express concerns regarding the accuracy and ethical implications of AI-generated outputs. These findings reveal a gap between widespread AI usage and structured pedagogical guidance, particularly in relation to prompting proficiency and responsible AI engagement.

One critical aspect of human and AI interaction lies in prompting, defined as the structured formulation of inputs to guide AI-generated responses. Prompt literacy, understood as the ability to construct effective queries and interpret AI outputs, has emerged as an important educational competency in the era of generative AI (Plaatjies & van Wyk, 2025). Effective prompting requires learners to clearly specify tasks, contextual constraints, and expected output formats in order to obtain meaningful and reliable results. Therefore, structured prompting pedagogy may function as a foundational mechanism for fostering responsible and self-directed engagement with AI within secondary education in Indonesia.

Although discussions on AI literacy and educational technology are expanding, there remains limited development research that systematically translates AI curriculum competencies into structured instructional modules at the secondary education level. Prior studies have primarily addressed AI literacy at a general conceptual level or focused on higher education contexts (Isdayani et al., 2024; Kasneji et al., 2023), without offering curriculum-aligned instructional tools that integrate structured prompting pedagogy within a nationally mandated secondary education framework. In particular, instructional tools that integrate ethical awareness, structured prompting strategies, and support for self-directed learning in a coherent format remain underexplored. Unlike previous works, this study specifically addresses the implementation gap within Indonesia's newly enacted Coding and Artificial Intelligence curriculum at Phase E, by developing a structured E-Module grounded in the R-T-C-F prompting framework and aligned with national Learning Outcomes. Accordingly, this study aims to develop and evaluate the feasibility and practicality of an interactive AI Prompting E-Module designed to support self-directed learning in senior high school students.

METHODS

This study employed a Research and Development (R&D) approach, which aims to develop an instructional product and evaluate its feasibility before broader implementation (Sugiyono, 2023). The development design applied in this research utilized the ADDIE model, consisting of five sequential stages: Analyze, Design, Development, Implementation, and Evaluation (Cahyadi, 2019; Mahfud & Fahrizki, 2020). The ADDIE model was selected because it provides a systematic and structured framework that ensures that the developed E-Module aligns with students' needs, curriculum standards, and instructional design principles.

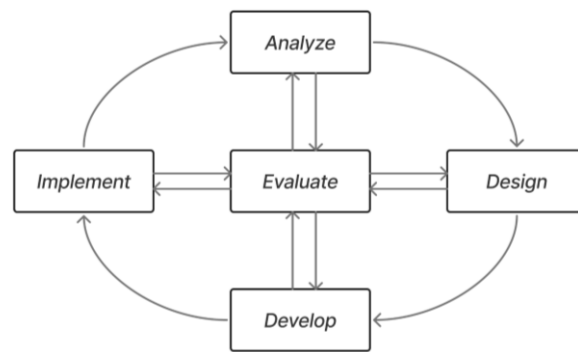


Figure 1. Research Procedure Based on the ADDIE Model

The implementation of the ADDIE model in this study followed a sequential and iterative process as illustrated in Figure 1. Each stage produced specific outputs that informed the subsequent phase, ensuring alignment between students' learning needs, curriculum standards, and the final E-Module product.

1. Analyze

At the Analyze stage, the primary activity focused on identifying students' needs in relation to the use of Artificial Intelligence (AI) in learning. A needs analysis questionnaire was distributed to Grade 10 students to collect data regarding patterns of AI usage, learning purposes, and challenges encountered when interacting with AI systems. The analysis revealed that although students frequently use AI for academic purposes, they still experience difficulties in constructing structured prompts and express concerns related to dependency and academic integrity. In addition, a curriculum analysis was conducted on the subject *Koding dan Kecerdasan Artifisial* (Coding and Artificial Intelligence) at Phase E. This stage involved examining the established *Capaian Pembelajaran* (Learning Outcomes) and served as the basis for formulating appropriate *Tujuan Pembelajaran* (Learning Objectives) to ensure that the developed E-Module aligns with the competencies mandated by the national curriculum.

2. Design

The Design stage involved translating the results of the needs and curriculum analysis into a structured instructional framework. This phase included determining learning objectives, organizing the sequence of materials, designing content flow, and preparing validation instruments. The E-Module was structured using a Problem-Based Learning approach to encourage active engagement and critical thinking. The design also incorporated the R-T-C-F prompting framework (Role, Task, Context, Format) as the core instructional strategy to help students construct more precise and intentional prompts when interacting with AI systems.

3. Development

During the Development stage, the conceptual design was transformed into a complete digital E-Module in flipbook format. The developed E-Module consists of four main components. First, it introduces generative AI concepts. Second, it discusses ethical and factual risks such as hallucination, bias, and plagiarism. Third, it presents structured prompting techniques using the R-T-C-F framework, iteration, and Socratic prompting. Finally, it provides reflective exercises to encourage critical engagement with AI outputs. In addition, the module incorporates a scaffolded AI assistant prototype designed to model step-by-step reasoning and discourage direct answer generation. This feature is embedded as part of the instructional content to reinforce responsible AI interaction. However, this prototype was not independently evaluated for effectiveness within the scope of the present study.

At this stage, the product underwent expert validation involving a material expert and a media expert. The selected experts met the required academic and professional qualifications in the relevant fields. The material expert

assessed content feasibility, language clarity, and presentation structure using 15 validation items, while the media expert evaluated visual design, usability, readability, and technical functionality using 14 validation items. Revisions were made based on expert feedback to improve the overall quality of the module.

4. Implementation

The Implementation stage involved a limited product trial with 35 Grade 10 students to obtain user responses. After revisions based on expert validation, the E-Module was distributed to students to obtain their responses regarding clarity of content, ease of use, attractiveness, and overall practicality. This stage aimed to determine the practicality of the developed product from the user perspective rather than to measure learning effectiveness.

5. Evaluation

The Evaluation stage was conducted as a formative evaluation throughout the development process. Feedback and quantitative scores obtained from both expert validation and user trials were analyzed to determine the feasibility level of the E-Module. The product was considered feasible when it met the predetermined eligibility criteria based on percentage interpretation.

Data Collection Techniques

Data were collected using structured questionnaires administered to three groups of evaluators: a material expert, a media expert, and students as end users of the developed E-Module.

Table 1. Material Expert Validation Instrument Grid

Aspect	Indicator Description	Item Numbers
Content Feasibility	Evaluation of the accuracy, relevance, depth, and curricular alignment of the AI prompting material presented in the module.	1-8
Language	Assessment of linguistic clarity, appropriateness for senior high school students, and compliance with formal language standards.	9-12
Presentation Feasibility	Evaluation of the logical organization, instructional coherence, and effectiveness of examples in supporting conceptual understanding.	13-15

Table 2. Media Expert Validation Instrument Grid

Aspect	Indicator Description	Item Numbers
Visual Attractiveness	Evaluation of the visual design and aesthetic consistency of the module interface.	1-4
Media Practicality	Assessment of usability and navigation efficiency in supporting self-directed learning.	5-6
Media Readability	Evaluation of the text clarity and structural organization to ensure ease of comprehension.	7-11
Media Readiness	Assessment of functional reliability and overall user comfort during module operation.	12-14

Table 3. User Trial Questionnaire Instrument

Aspect	Indicator Description	Item Numbers
Media Attractiveness	Students' perception of the module's visual appeal and overall engagement.	1-4
Ease of Use	Students' perception of accessibility, navigation clarity, and operational simplicity.	5-8
Material Comprehensibility	Students' perception of the clarity and understandability of AI prompting concepts presented in the module.	9-12

Data Analysis Techniques

This study employed a quantitative descriptive approach for data analysis using a Likert-scale measurement model. The Likert scale was utilized to measure respondents' perceptions, attitudes, and evaluations toward the research object. According to Sugiyono (2023), the Likert scale is widely used in quantitative research to quantify subjective responses into measurable numerical data for statistical analysis.

The research instrument consisted of a four-point Likert scale designed to eliminate neutral responses and encourage decisive evaluations. The scoring categories were defined as follows:

Table 4. Likert Scale Scoring Criteria (1-4)

Score	Category
1	Strongly Disagree
2	Disagree
3	Agree
4	Strongly Agree

The total score was obtained by summing all responses provided by the respondents across all questionnaire items. Subsequently, the level of feasibility of the product was determined by converting the total score into a percentage using the following formula:

$$P = \frac{\text{Total Score Obtained}}{\text{Maximum Score per Indicator}} \times 100\%$$

This percentage-based approach allows the transformation of ordinal Likert-scale data into an interpretable index representing the overall evaluation result (Sugiyono, 2023). The resulting percentage values were interpreted using the following feasibility criteria that were used to determine the overall feasibility of the product based on expert validation and user responses.

Table 5. Feasibility Percentage Interpretation Criteria

Percentage Range	Category
0-25%	Not Feasible
26-50%	Less Feasible
51-75%	Feasible
76-100%	Very Feasible

Instrument Validity and Reliability

The user trial questionnaire underwent validity and reliability testing with 35 respondents to ensure its psychometric soundness. The user trial instrument underwent rigorous validity and reliability testing involving 35 respondents. The validity test, measured using the Pearson Product-Moment correlation, revealed that all 12 items were valid, with correlation coefficients (r_{count}) ranging from 0.573 to 0.825. These values significantly exceeded the critical value of $r_{\text{table}} = 0.334$ at a 5% significance level. Furthermore, the reliability analysis yielded a Cronbach's Alpha coefficient of 0.93, indicating excellent internal consistency. Consequently, the instrument was deemed highly stable and appropriate for data collection.

RESULTS AND DISCUSSIONS

Product Description

The product developed in this study is an interactive digital E-Module entitled “*Interactive Prompting Techniques E-Module: Mastering AI Wisely and Critically.*” The module is presented in a flipbook format consisting of 45 pages and is structured using a Problem-Based Learning (PBL) approach organized into four main sections. The development of the E-Module was grounded in curriculum analysis of the Learning Outcomes for the Coding and Artificial Intelligence subject at Phase E. The analysis emphasized competencies related to ethical responsibility, AI literacy, and prompt engineering, particularly addressing students’ difficulties in understanding AI hallucination, bias, plagiarism, and effective prompt construction.

Based on the identified Learning Outcomes, the module was structured into three core instructional domains: (1) conceptual understanding of generative AI at an intermediate level, (2) analysis of ethical and factual risks in AI use, and (3) structured prompting strategies supported by reflective evaluation practices. Through the PBL-oriented structure, students are guided to identify common AI-related problems, explore ethical implications, construct prompts systematically using the R-T-C-F framework (Role, Task, Context, Format), apply iterative refinement techniques, implement Socratic prompting strategies, and evaluate AI-generated outputs critically.

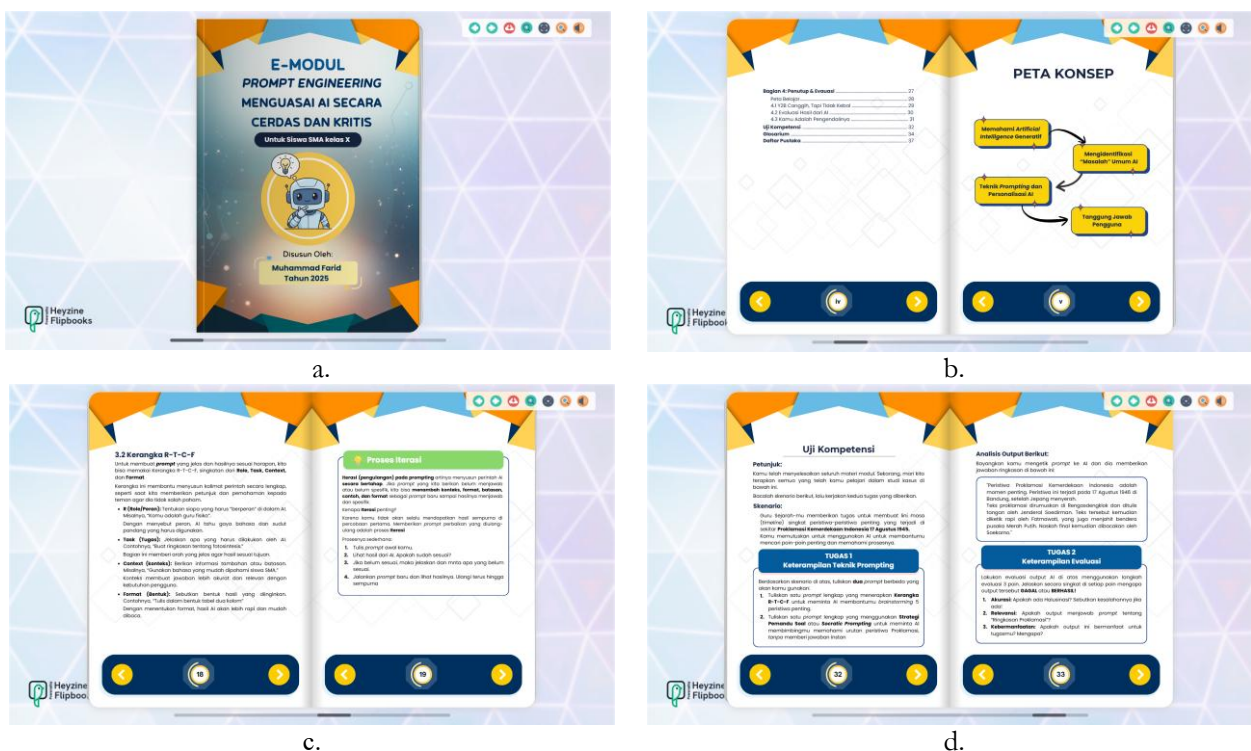


Figure 2. Product Footage, a) E-Module Cover, b) Concept Map of the E-Module Structure, c) Example of Structured Prompting Page, d) Practice Page

Expert Validation

The material expert validation resulted in an average total score of 90%, categorized as Very Feasible, as presented in Table 6. This finding indicates that the module content is aligned with the intended learning objectives and is presented in a structured and pedagogically appropriate manner. The highest score was achieved in the Presentation Feasibility aspect (91,67%), reflecting the logical organization and effectiveness of examples embedded in the module.

Table 6. Material Expert Validation Results

Aspect	Percentage Score
Content Feasibility	90,62%
Language	87,5%
Presentation Feasibility	91,67%
Average Total	90%

The media expert validation produced an average total score of 87.5%, categorized as Very Feasible, as presented in Table 7. These results suggest that the digital flipbook format is visually coherent, functionally reliable, and suitable for instructional use, with Media Readiness receiving the highest score (91,67%).

Table 7. Media Expert Validation Results

Aspect	Percentage Score
Visual Attractiveness	87,5%
Media Practicality	87,5%
Media Readability	85%
Media Readiness	91,67%
Average Total	87,5%

Overall, the feasibility of the developed E-Module was evaluated through material expert and media expert validation. The results indicate that the product achieved a Very Feasible category in both evaluations based on the average total percentage scores.

User Trial Results

The limited user trial was conducted with 35 students to evaluate the practicality and perceived effectiveness of the developed E-Module. The results indicate that the module achieved an average total score of 81,72%, categorized as Very Feasible, as presented in Table 8. This finding suggests that the module is positively received by students across all three aspects evaluated, with Material Comprehensibility obtaining the highest score (82.5%), followed by Media Attractiveness (82.32%) and Ease of Use (80.35%).

Table 8. User Trial Results

Aspect	Percentage Score
Media Attractiveness	82,32%
Ease of Use	80,35%
Material Comprehensibility	82,5%
Average Total	81,72%

Discussion

The results indicate that the developed interactive E-Module achieved a Very Feasible category across material validation, media validation, and user trial evaluations. Beyond its feasibility, the significance of this development lies in its potential role as a bridging instructional tool during the transitional implementation of the Coding and Artificial Intelligence curriculum at the secondary education level.

This gap is further reflected in the needs analysis findings, where high AI usage coexists with difficulties in structured prompting and evaluative competence. This pattern aligns with the systematic literature review conducted by (Park, 2025), which delineates five core competencies essential for GenAI literacy in school contexts: knowing and understanding GenAI, using and applying GenAI, evaluating and creating GenAI, ethical considerations, and AI attitudes. These dimensions remain underdeveloped when students engage with AI without structured instructional support. Consequently, the developed E-Module directly targets these competency gaps by embedding ethical risk analysis, structured prompting strategies, and reflective evaluation tasks within a coherent instructional framework.

The centrality of structured prompting as a pedagogical strategy in this module is grounded in an emerging body of scholarship on prompt literacy. Prompt literacy—defined as the combination of knowledge, skills, and understanding necessary for dynamic and iterative interactions with generative AI—is increasingly regarded as an essential competency in AI-integrated education (Tour & Zadorozhnyy, 2025). Federiakin et al. (2024) further argue that prompt engineering constitutes a new 21st-century skill that existing digital and information literacy frameworks have yet to adequately address, as these frameworks were primarily designed for search-engine-based inquiry and do not cover the specific demands of interacting with large language models. To address this competency gap, the R-T-C-F framework (Role, Task, Context, and Format) is implemented in this module to

provide students with a structured scaffold for constructing precise prompts. Ultimately, by embedding these structured scaffolds within the curriculum, the module transforms AI interaction into a deliberate cognitive exercise that not only enhances technical proficiency but also fosters the critical thinking skills essential for navigating the complexities of an AI-driven era.

Furthermore, the positive user trial results indicate that the module is practically usable in self-directed learning contexts. The digital flipbook format, combined with guided examples and reflective tasks, enables students to navigate the material autonomously while maintaining structured instructional support. Overall, the findings suggest that the developed E-Module can function both as a bridge between curriculum standards and classroom implementation and as a practical resource for fostering self-directed AI literacy learning.

CONCLUSIONS

This study developed an interactive E-Module on AI prompting techniques designed to support self-directed learning at the secondary education level. The development was motivated by an identified gap between students' high frequency of AI usage and their limited capacity for structured prompting and critical evaluation of AI-generated outputs. The results confirm that this gap can be addressed through a structured, curriculum-aligned instructional module: Based on material validation (90%), media validation (87.5%), and user trial results (81.72%), the module achieved a Very Feasible rating across all evaluation domains, demonstrating its capacity to provide structured AI prompting guidance within the context of Indonesia's national Coding and Artificial Intelligence curriculum. These findings indicate that the developed E-Module is pedagogically appropriate, technically functional, and practically usable by students. By translating curriculum Learning Outcomes into structured prompting strategies and ethical AI literacy practices, the module serves as a practical bridge between national curriculum expectations and classroom implementation while fostering students' self-directed and responsible engagement with generative AI technologies.

However, this study is subject to several limitations. First, the trial was conducted within a single educational setting with a limited sample of 35 students, which constrains the generalizability of the findings. Second, the developed E-Module incorporates a scaffolded AI assistant prototype designed to model step-by-step reasoning and discourage passive answer-seeking behavior; however, this prototype was not independently evaluated for instructional effectiveness within the scope of the present study. Its inclusion was intended as a design feature to reinforce responsible AI interaction, and its pedagogical impact warrants dedicated investigation in future research. Third, this study measured feasibility and practicality rather than learning effectiveness; accordingly, future research should incorporate pre- and post-test designs to empirically assess the module's impact on students' prompting proficiency and AI literacy competencies. Broader replication across diverse school contexts and student populations is also recommended to strengthen the evidence base for this instructional approach.

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